BELL'S

NAUTICAL INSTRUCTOR

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NAUTICAL INSTRUCTOR

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H. HUGHES, 59, FENCHURCH STREET, E.C.;

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THE

NAUTICAL INSTRUCTOR:

A COMPENDIUM OF

PRACTICAL NAVIGATION,

CONTAINING

EXAMPLES AND FORMULÆ

FOR ALL THE

PROBLEMS USED AT SEA;

WITH

ASTRONOMICAL DEFINITIONS,

ILLUSTRATED BY SPHERICAL AND PLANE DIAGRAMS:

BY CAPTAIN J. H. BELL,

(Over Thirty Years a Master in the Mercantile Marine;)

TOGETHER WITH

VALUABLE INFORMATION AND ADVICE TO YOUNG NAVIGATORS:

SO ARRANGED AS TO ENABLE THE STUDENT TO MASTER THE SCIENCE OF NAVIGATION WITHOUT THE ASSISTANCE OF A TEACHER.

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PREFACE.

The publication of a "Compendium of Practical Navigation, Illustrated by Spherical and Plane Diagrams," &c., &c., at the present day needs neither explanation nor apology. The general utility of the subjects treated of, in this and other works on Navigation, are sufficient to recommend such works to the early attention of every youth who intends to follow the sea as a profession. But as this work contains VALUABLE INFORMATION AND ADVICE to the young navigator, and as that valuable information embraces the duties of commanders and officers, the publication of these *may* seem to require some explanation, if not an apology. The best apology will perhaps be found in the circumstances which led to the idea of this mode and manner of doing so.

In the course of a long and arduous professional career, the Author has discovered, not unfrequently, that lamentable ignorance prevailed among a large number of nautical men on the most important points immediately connected with their duty, and involving the best interests of the ship-owner and underwriter. That this ignorance prevails to a lamentable extent at the present day is manifested in almost every case of marine disaster, and is the natural and inevitable result of a defective education, insufficient nautical training, and the ridiculous system adopted by the Board of Trade, requiring officers to show their ability on parchment, rather than on the quarter deck, or on the yard-arm; and to the fact that our schools on land are adapted to the wants of landsmen only, the education to be had there having never been made to bear directly on the future requirements of the ship-master; and it may be owing, in some measure, to the very extensive range of information on various subjects required in efficient commanders.

Another cause of this ignorance has been the want of a concise *practical* treatise on this subject, written by a practical man, whose desire is to elevate and improve the moral, professional, and social condition of British seamen. This is the sincere desire of the Author, and he believes that the best and speediest method to attain that object is the improvement of the officers and commanders. He begins with the duties of second mate, those of the chief mate and master follow, and are discussed in the same manner. In order that the ideas conveyed shall be the better understood, the Author considers himself as speaking to those for whom the information is intended. But at the same time he does not affect to prescribe to the intelligent ship-master what should be the line of conduct adopted in *every* case, but simply to point out to those who do not know what the parties interested *expect*, and what the honor of the country and the law requires at the hands of all who are entrusted with life and property at sea.

In their proper places will be found familiar examples in all the problems necessary in the navigation of a ship from one part of the world to another, these are illustrated by diagrams, with the manner of constructing them; the whole divested of all mystery, with a view to render this noble science comprehensible to those whose circumstances have prevented them from acquiring a mathematical education, but whose laudable ambition points to the honorable position of a commander in the Mercantile Marine.

Nautical Education is the great want of the age, calculated, as it is, to elevate and improve the moral and social position of a most noble, though much neglected class of this commercial community. It is generally acknowledged that, in order to improve seamen, either intellectually or morally, it is of all things, and before all things, necessary to have a properly qualified, and well educated, gentlemanly class of officers. Now, as officers should be made of men who have served "before the mast," it is but right that every youth should have an opportunity to acquire that knowledge which will enable him to rise in his profession. It is hoped that by carefully studying the rules, committing to memory the questions and the answers on busi-

ness matters (by far the most important part of the ship-master's duties), and by following the precepts laid down in this little work, the difficulties too often thrown round the science of Navigation will entirely disappear, and many who, as far as seamanship is concerned, are fit to hold *any* position on board of ship, will be led to begin, AT ONCE, to fit themselves for that high and honorable position to which the proper knowledge, combined with good conduct and integrity, must inevitably lead.

How far I have succeeded in supplying a desideratum which has hitherto been felt by those nautical men who have not had the advantage of a law library, nor time to wade through the numerous volumes containing the information here condensed for their convenience, is not for me, but for the nautical student to determine. To their decision I submit the question, under the conviction that, whatever may be the defects in the execution, the reader will do justice to my motives in the attempt to lessen the obstructions in the way of obtaining a practical knowledge of nautical science and business transactions.

THE AUTHOR.

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QUALIFICATIONS FOR CHIEF MATE.

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Explanation of Figure, page 12.—1st quadrant N A E O :—A E = 90°. = Radius = 1 = 10.00000. N O, A E, O E each = Radius. N O and O E are Tangents of 45°. = Radius = Chord of 60°. arc N B E = 90°., and arc E B and B N = 45°. each. B D and B K are each sines of 45°. = D A and A K. A B O is the secant of 45°. = Radius = 10.000000. E K and N D are respectively the versed and co-versed sines of 45°. H S is the chord of 45°. and S W the chord of 90°. The arc S H W, cut off by the chord S W is called a segment. W E and N S are = and are diameters.

Abbreviations and Signs.

$+$ means *addition*, and denotes that whatever quantities follow, the sign must be added to those that go before it; thus, $12+12$ means that 12 is to be added to 12, or if we call 6 B and 7 C, then $B+C$ means that 6 is to be added to 7.

— means *subtraction*, and denotes that the numbers following it must be subtracted from those that go before it; thus, 17—8 signifies that 8 is to be subtracted from 17.

$\times$ means *multiplication*, and signifies that the numbers placed before and after it are to be multiplied into each other; thus, 16×4, signifies that 16 is to be multiplied by 4, and if we call 16 B and 4 D, then $B \times D$, means that B is to be multiplied by D, or 16 multiplied by 4 as before.

$\div$ means *division*, and denotes that the numbers standing before it are to be divided by those that follow it; as, $125 \div 5$ shows that 125 is to be divided by 5, or division is denoted $\frac{125}{5}$ shows that 125 is to be divided by 5. Now if we call 125 B, and 5 C, we express the same thus, $\frac{B}{C}$ which signifies that B is to be divided by C.

$=$ is the sign of equality, or equal to, and denotes that the numbers or quantities placed before are equal to those placed after it; thus, $2+6+8=16$, or $2 \times 8=16$, or $3+6 \times 8 \div 12=6$.

° means degrees, thus 40°. means 40 degrees of a circle.

′ signifies minutes, or the 60th part of a degree.

″ denotes seconds, or the 60th part of a minute of a circle.

‴ means thirds, or the 60th part of a second of a circle.

H. or h. signifies hours.

M. or m. is the mark for minutes of time.

S. or s. is placed for seconds of time.

S. means South.

N. for North.

E. for East, and

W. for West.

S. also signifies Sine. N. S. Natural Sine.

Sec. means Secant.

Co-sec. Co-secant.

Tan. means Tangent.

V. S. Versed Sine.

S. T. Semi-tangent.

Co-sine, Co-secant, Co-tangent of any arc or angle, means the Sine, Secant, or Tangent of the complement of the same arc or angle.

∠ signifies Angle.

☉ signifies Sun.

◐ or ☽ stands for Moon. Z. D. Zenith distance.

✱ for Star or Planet. S. D. Semi-diameter.

L. L. means Lower Limb.

U. L. means Upper Limb. P. L. Proportional Logarithm.

: means Proportion. : : this mark is placed between the second and third terms, and : is placed between the third and fourth terms. Thus:—As 15 : 20 : : 75 : 100. This reads, as fifteen is to twenty, so is seventy-five to one hundred.

PRACTICAL NAVIGATION.

QUALIFICATIONS FOR A SECOND MATE.

In order to feel in every way qualified to hold the office of Second Mate in any ship, it is absolutely necessary, that a young man should have served as able seaman before the mast, and that he is in all things smarter than his fellows. Otherwise, what claim can he have to the position of an officer? Now to be duly qualified in seamanship, five years' service is quite little enough, and seven would be much better. Every second officer should be at least twenty-one years old, should write a good hand, and understand the first four rules of arithmetic and decimal fractions, as well as the use and application of logarithms. Hence, the exercises are given in decimals, with the rules for working them, viz :—

ADDITION OF DECIMALS.

This is performed exactly as in whole numbers, placing the numbers of the same denomination under each other. If this be done the decimal points (.) will be in a straight line in one column under each other.

PROBLEMS 1, 2.

Example 1.

Add together 141.37; 13.762; 37.03; 409.3976.

Example 2.

Add together 13.268; 108.1; 276.44; 14.7845.

1*st.*	2*nd.*
141.37	13.268
13.762	108.1
37.03	276.44
409.3976	14.7845
Sum 601.5596	412.5925 Sum.

SUBTRACTION OF DECIMALS.

Rule.—Subtraction of decimals is performed in the same way as whole numbers, observing to set the whole numbers and decimals so that the decimal points (.) shall be under each other, thus:—

PROBLEM 3.

Examples 1, 2, 3.

From	131.267	26.75	11.254
Take	2.63	0.26	.416
	128.637	26.49	10.838

MULTIPLICATION OF DECIMALS.

Rule.—This is performed by multiplying the numbers together as in whole numbers, and pointing off as many decimals from the right hand as there are decimals in both factors. Should it happen that there are not so many figures in the product as there must be decimals, then place as many ciphers to the left hand as will supply the deficiency.

PROBLEMS 4, 5.

Example 1.

Multiply 2.4362 by .275

```
  2.4362
    .275
  ------
  121810
 170534
 48724
---------
0.6699550 Product.
```

Example 2.

Multiply 376.09 by 13.43

```
    376.09
     13.43
    ------
    112827
   150436
  112827
  37609
 ---------
5050.8887 Product.
```

DIVISION OF DECIMALS.

Rule.—Division of Decimals is performed in the same way as that of whole numbers, only observing that the number of decimals in the quotient must be equal to the excess of the number of decimals of the dividend above those of the divisor. When the divisor contains

more decimals than the dividend, ciphers must be affixed to the right hand of the latter, to make it equal to or exceed the number of the divisor.

PROBLEMS 6, 7.

Example 1.
Divide .669955 by .275

```
.275) .669955 ( 2.4362
       550
       ----
       1199
       1100
       ----
         995
         825
         ----
        1705
        1650
        ----
          550
          550
```

Example 2.
Divide 5050.8887 by 13.43

```
13.43 ) 5050.8887 ( 376.09
        4029
        -----
        10218
         9401
        ------
          8178
          8058
          ------
           12087
           12087
```

PROBLEM 8.

Example 1.

RULE OF THREE IN DECIMALS.

At what rate per hour are the inhabitants of a place in latitude 37° 16′ N. carried forward form West towards the East?

By reference to the tables (No. 2 Norie's Epitome), it will be seen that the degree of longitude in latitude 37° 16′ is = 46.7 miles. Then

$$360° \times 46.7 = 16812, \text{ and}$$

As 23.9333 h.) : 16812 : : 1 h. (702. miles nearly.

```
168120000
1675331
---------
   586900
   478666
   ------
   108234
```

REDUCTION OF DECIMALS.

Rule.—To reduce a vulgar fraction to a decimal of equal value, add any number of ciphers to the numerator, and divide by the denominator, the quotient will be the decimal fraction required. The decimal point must be placed so that there may be as many figures to the right hand of it as were added ciphers to the numerator. If there are not as many figures in the quotient, ciphers must be placed to the left hand to supply the deficiency.

PROBLEMS 9, 10.

Example 1.

Reduce 4 h. 10 m. 50 sec. to the decimal of a day;

Example 2.

Reduce 49′ 30″ to the decimal of a degree;

1*st.*

4 h. 10 m. 50 sec.
60
250
60
86400 s) 15050 s .00000 (.17419
8640 0 Nearly.
641000
604800
362000
345600
164000
86400
776000
777600

2*nd.*

49′ 30″
60
3600″) 2970″.000 (.825 of an hour.
28800
9000
7200
18000
18000

QUESTIONS ON THE COMPASS.

What is the Mariner's compass, and of what materials is it composed?

The Mariner's compass is an instrument so constructed as to represent the horizon. It is composed of a steel bar called the *needle*, which

being saturated with electricity, and fixed to a circular card, and placed on a finely pointed *brass* pivot, naturally points to the poles; the pivot and its card are placed in a *brass* or *wooden* box, upright.

The pivot is usually fixed in lead, and the box containing the pivot and card is hung in gimbles. The steel needle being saturated with electricity, points North and South, and the point of the card immediately over the North point of the magnetic needle is marked North, the opposite point South, and each hemisphere is divided into sixteen equal parts, called points, each point contains 11° 15′. Therefore there are thirty-two points contained in the whole circle, equal to 360°.

The compass card is an artificial representation of the horizon, which is a *great circle*, containing 360°.

Why is lead placed in the compass bowl?

Because it gives weight to the bowl, and thus serves to keep the pivot on which the compass card and needle are poised, in a perpendicular position, and the compass constantly level.

Of what material is the pivot and gimbles of which you have spoken, and why is brass or wood used for the compass bowl?

The pivot is usually of brass as well as the gimbles and bowl, because brass or copper will not interfere with the electric fluid passing through the magnetic needle, while iron, tin, or steel, would very much distract the needle, and cause errors to be made in the ship's course.

What is the ship's course?

The angle which the ship's keel and track makes with the meridian of the place from which she sailed.

Does the Mariner's compass always point true North and South in all places?

No. The compass does not point to the true North. It in some places points to the Eastward, and in other places to the Westward; its error is called variation. Westerly variation is familiarly represented by a watch that is too fast; the true course being to the left hand of the compass or magnetic course. And Easterly variation is represented by a watch that is too slow; the true course being to the right hand of the magnetic or compass course.

Are there any other local or circumstantial errors for which corrections are to be applied to the apparent courses steered by a ship at sea?

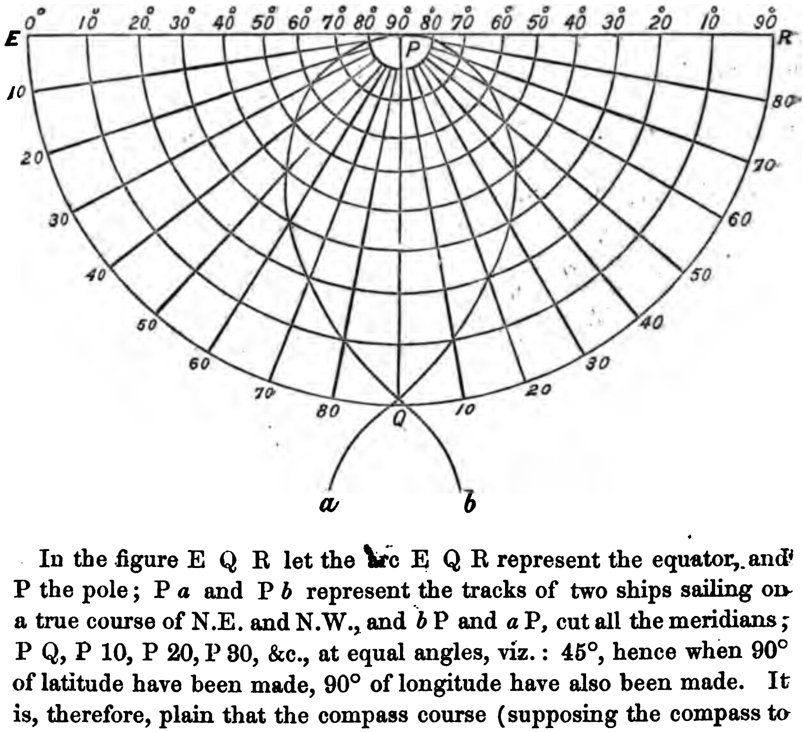
Yes. When a ship is on a wind with her yards sharp braced up, she makes drift, called lee way, in proportion to the quantityof sail set, roughness of the sea, the ship's model, &c., which must be allowed for on all

such courses. There is also an error arising from the local attraction of the ship, her rigging, machinery, guns or cargo, which must be ascertained *for every point of the compass*, and allowed on all courses steered, in order to ascertain the true course made good.

What is a rhumb line?

It is a direction indicated by a compass, and is called a loxodromic curve, or spiral.

Suppose two ships start from the equator, one steers N. 45° W., and the other S. 45° E., or N.W. and S.E. (true) where would they get to? The one to the North, and the other to the South pole.



In the figure E Q R let the arc E Q R represent the equator, and P the pole; P *a* and P *b* represent the tracks of two ships sailing on a true course of N.E. and N.W., and *b* P and *a* P, cut all the meridians; P Q, P 10, P 20, P 30, &c., at equal angles, viz.: 45°, hence when 90° of latitude have been made, 90° of longitude have also been made. It is, therefore, plain that the compass course (supposing the compass to have no variation or error of any kind) is not a straight line. It would be so, however, if the world were an extended plain surface, as is supposed to be the case in coasting, and on short runs. The primitive circle is drawn with the chord of 60° taken from the common Gunter scale. The parallels of latitude are drawn by the line of semi-tangents, and the meridians are laid off on the equator with the chords of their several distances from the Colures, R P, E P, and P Q.

PROBLEM 11.

Correct the following course steered, for lee way, variation, and local attraction, and show the true course:—

Compass Course.	Winds.	Lee way.	Variation.	Local Attraction.	True Course.
S.S.E. ½ E.	S.W.	1½	2¼ W.	½ E.	S. 5¾ pts. E.
N.E. ¼ N.	E.S.E.	1¼	1¾ E.	¼ W.	N. 45° E.
S.W. ½ S.	W.N.W.	2½	1½ W.	4° E.	S. 1°.37′ E.
N.W. ¾ W.	W.S.W.	1¼	2¾ E.	7° W.	N. 15°.26′ W.
North.	E.N.E.	2¾	2¼ W.	9° E.	N. 47°.15′ W.

QUESTIONS ON THE GLOBES AS TO LATITUDE, LONGITUDE, DECLINATION, AND RIGHT ASCENSION.

What is Navigation ?

The art of conducting a ship from one part of the world to another, by the shortest and most safe and expeditious routes.

How is this performed ?

By finding the course steered, distance run, and the latitude and longitude of the ship's daily position, and continuing to steer as near as possible directly towards the place, or in the best route to the place bound to.

What is Latitude ?

Latitude is the distance of the zenith of any place North or South of the Equator, measured on the meridian of that place. (as EL, EI, &c.)

What is the difference of latitude between two places ?

The difference of latitude between two places is the arc of a meridian intercepted between the two parallels passing through those places. (as ♋ L, LI, &c.)

What is a parallel ?

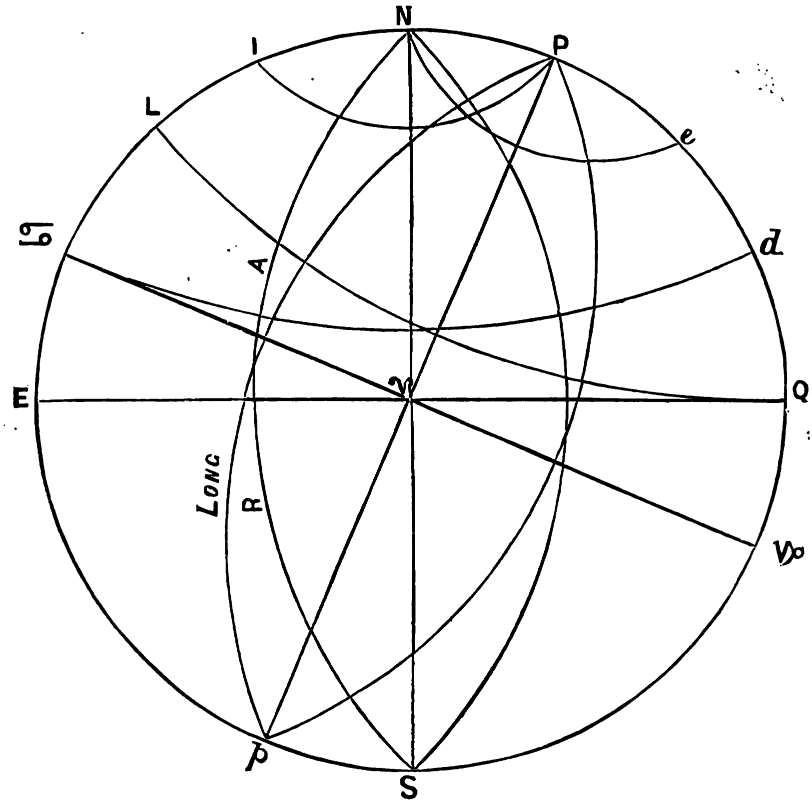
A small circle running parallel to the Equator, or any other great circle, at any distance from it. (as IP, ♋ d.)

What is meant by the longitude of the sun, moon, or star ?

The longitude of any heavenly body is its distance from the first point of Aries, measured on the ecliptic as ♋ ♈ = 90°.

What is celestial latitude ?

Distance North or South of the ecliptic, and a star may have South latitude, while its declination is North; and *vice versa*, (as L Q, Figure, page 8.)



What is the difference of latitude between Bermuda and the Cape of Good Hope, in degrees and miles ?

Latitude of Bermuda ... ... 32°.08′ N. of the Equator.
Latitude of Cape of Good Hope ... ... 34°.22′ S. " "

Add because on different sides of the Equator 66°.30′ in degrees.
There are 60 miles in each degree ... × 60

Difference of latitude ... 3990 in miles.

What is the difference of latitude
between Cape Clear, in latitude ... 51°.26′ North of the Equator.
and Oporto, in latitude ... ... 41°.09′ North of the Equator.

Subtract because both North (or South) 10°.17′ difference in deg.
60 miles in each degree 60

Difference of latitude 617 in miles.

To find the difference of latitude between any two places.

Rule.—If the places be both North or both South, subtract the less from the greater, and the remainder will be the *difference* of *latitude* sought. But if one be North and the other South, add the two latitudes together, and the sum will be the *difference* of *latitude* sought.

What is Longitude ?

Longitude is an arc of the Equator intercepted between the meridian of Greenwich and any other meridian, or longitude is a quantity of time called a Horary angle turned into motion, the angular point being formed at the poles and measured on the Equator. (E N ♈, Fig. page 8.)

The difference of longitude between two places, is that arc of the Equator which is intercepted between the meridians which pass through the zeniths of those two places. Degrees of longitude, like those of latitude, contain 60′ minutes each, which is equal to 4 minutes of time ; hence one hour of time is equal to 15° of longitude, and 24 hours of time is equal to 360°.

Required the difference of longitude between New York and St. Helena in degrees and also in miles.

Longitude of New York	74°.00′	West of Greenwich.
Longitude of St. Helena ...	5°.45′	„ „
Subtract less from greater ...	68°.15′	Difference in degrees.
60 miles make one degree ...	60	
Difference of longitude ..	4095	in miles.

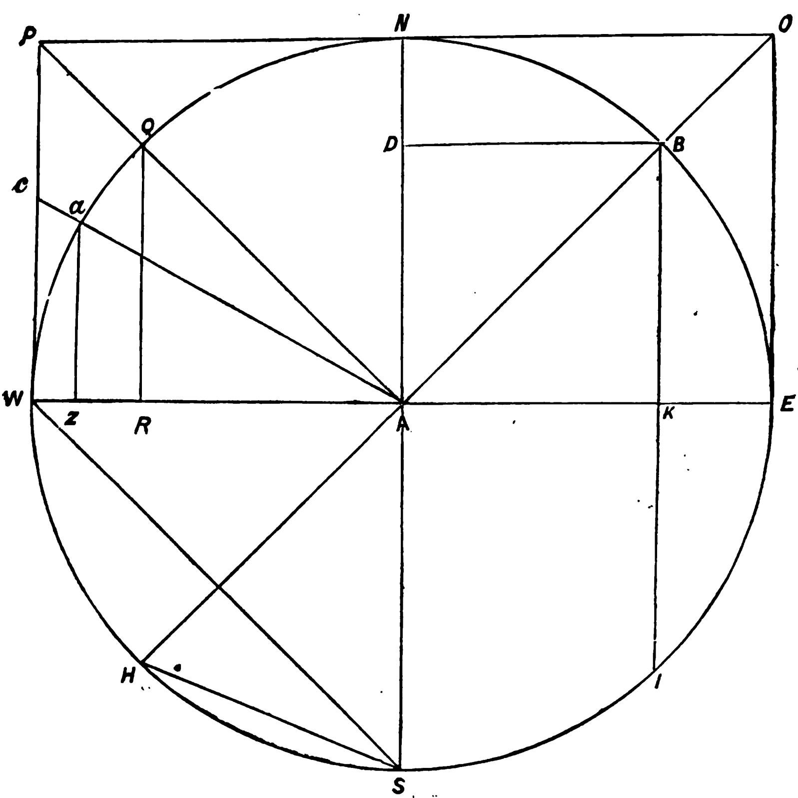
Required the difference of longitude between Cape Henry, in America, and Madeira Island, on the Coast of Africa.

Longitude of Cape Henry	76°.00′	West.
Ditto Island of Madeira	16°.38′	„
Subtract less from greater		
Difference of longitude in degrees	59°.22′	
60 miles make one degree	60	
Difference of longitude in miles ...	3562	

Yesterday I was in latitude 55° 26′ N.; since then I have sailed South 211 miles. Required my present latitude.

Yesterday's latitude	55°.26′	North.
Difference of latitude 211 miles ÷ 60 ... =	3°.31′	Southing.
Latitude in	51°.55′	North.

circumference of any circle, as A E, A N, &c., and is made to represent *unity* or one. But this is comprised of any number of decimal parts, say 10.00000. Now it is evident that if a side of any right angled tiangle be made radius, (that is if a circle be described round any side) the other sides will be greater or less than that side, *in proportion to* its length, and in proportion also to the angles opposite to those sides. Therefore the solution is performed by the rule of proportion. And in every statement where one side and an angle is given, or two sides and an angle, to find the other side, or sides, radius is the divisor, and therefore stands first in the proportion. But when an angle is sought, in which case two sides at least must be given, the side-made radius becomes the divisor, and, therefore, must stand first in the proportion.



What is the sine of an angle (or of a course)?

The sine of a course or angle is the quotient obtained by dividing

the side opposite that angle by the hypothenuse, as thus in the foregoing problem. We have the hypothenuse of the triangle or distance, 300 miles; the perpendicular or difference of latitude, 249.5 miles, and the base or departure 166.7. Now if we call the hypothenuse H, the perpendicular P, and the departure or base B, then by the above, to find the *sine* of the *course*, we have $\frac{B}{H} = \text{sine} \angle A = \text{co-sine} \angle C$; and $\frac{P}{H} = \text{sine} \angle C = \text{cosine} \angle A$.

Thus logarithmic value of B	... ... Log.	2.22186
„ „ H	... ... Log.	2.47712
Log. sine of angle opposite base or of the course 3 points.	... ... Sine	9.74474

Again.

Logrithmic value of P	... ... Log.	2.39697
„ „ H	... ... Log.	2.47712
Log. co-sine of course, or sine* of ∠ C	... ...	9.91985

PROBLEM 13.

GIVEN COURSE AND DEPARTURE TO FIND THE DIFFERENCE OF LATITUDE AND DISTANCE SAILED.

A ship from latitude 27° N., sails S.W. by W.¼W., until she has made 350 miles of departure.

Required her present latitude and distance sailed.

Solution by Logarithms.

To find the difference of latitude.

As radius			10.00000
Is to the departure 350 miles ...		Log.	2.54407
So is co-tangent course, 5¼ points		Co-Tang.	9.72796
To the different latitude	60) 187.1	Log.	2.27203
Different Latitude made	3°.07′.06″ S.		
Latitude left..............	27°.00′.00″ N.		
Latitude in	23°.52′.54″ N.		

* It will be seen that the Sines and Co-sines thus obtained are the same as those found in the tables. The Sine and Co-sine of any arc or angle may thus easily be found without an Epitome. All that is necessary is a table of Logarithms.

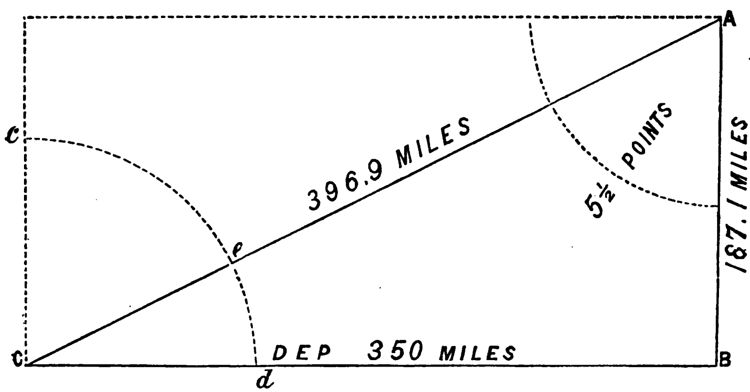
To find the distance.

As radius		10.00000
Is to the departure 350	Log.	2.54407
So is co-secant course, 5½ points	Log.	10.05457
To the distance sailed, 396.9	Log.	2.59864

Solution by Inspection.

First find the course in table 1. Over that course, find the departure in the column marked *Dep.* abreast of this in the difference of latitude column will be found 187, and in the distance column 396.9.*

Solution by Construction.



Draw the East and West line, B C, and make it equal to 350 miles. Now with the chord of 60° in the compasses, and one foot in the C describe an arc *d c* on which lay off 2½ points *d e* (the compliment of the course), mark this extent, through this mark, from C, draw the hypothenuse cutting A B in A, and it is done, for A B will measure 187.1, and C A 396.9.

QUESTIONS ON THE FOREGOING.

What is the tangent or co-tangent of an angle or course?

The tangent of an angle or of a course, is the quotient obtained by dividing the side opposite to the angle by the adjacent side, and the tangent of any angle is the co-tangent of its compliments. Thus, if, as

* When the numbers are too large for those of the columns, half or quarter of the numbers should be used, taking care to multiply the numbers taken out by 2, 4, &c., as the case may be.

in the former example, the departure or base be expressed by B; the hypothenuse or distance by H, and the difference of latitude or perpendicular by P, we shall have $\frac{B}{P}$ = tangent $\angle$ B and co-tangent $\angle$ A (the course) and $\frac{P}{B}$ = tangent $\angle$ A and co-tangent $\angle$ B: thus: —(See Figure page 14.)

Logarithmic value of B = 850	Log.	2.54407
„ „ „ P = 187.1	Log.	2.27203
Co-tangent 2½ points and Tangent 5½ points*	=	10.27204

Logarithmic value of P = 187.1	Log.	2.27203
„ „ „ B = 850	Log.	2.54407
Tangent of 2½ points and co-tangent of 5½.	Co-tang.	9.72796

What is the secant and co-secant of an angle or of a course?

The secant of an angle or of a course is the quotient obtained by dividing the hypothenuse by the side adjacent to the given angle; thus:—

Logarithmic value of H = 896.9	Log.	2.59864
„ „ „ P = 187.1	Log.	2.27203
Co-secant of 2½ points, 5½ pts....	Secant	10.32661

Logarithmic value of H 896.9	Log.	2.59864
„ „ „ B 850	Log.	2.54407
Secant of 2½ points, 5½ pts. co-secant ...		10.05457

What part of a triangle does the difference of latitude represent?

The perpendicular, because it is measured on the meridian.

What part of a triangle does the departure represent?

The base, because it is at right angles to the meridian.

What part of a triangle does the ship's track represent when she is sailing in such a manner as to form an angle with the meridian?

The hypothenuse, because while she makes distance she also makes latitude and departure.

---

* The tangents and co-tangents, secants and co-secants, thus obtained are the same as those given in the tables, as will be found by reference to the Epitomes.

What part of a *circle* does the departure represent when the course and distance are given?

The sine of the angle or course.

How are sines and co-sines distinguished from tangents and co-tangents?

Because sines and co-sines form right angles with each other, and always *inside* of the circle; while tangents and co-tangents form right angles with each other *outside* of the circle.

What part of a circle does the distance represent?

The secant of the course, when the difference of latitude is made radius, and the co-secant of the course when the departure is made radius, which must be the case when the departure and course are given to find the difference of latitude and distance, as in the last example.

What relation does the difference of latitude bear to the circle when the course and departure are given, as in the last example?

The departure being made radius, the difference of latitude becomes the co-tangent of the course, and the distance is represented by the co-secant of the course.

PROBLEM 14.

GIVEN THE DIFFERENCE OF LATITUDE AND THE DEPARTURE TO FIND THE COURSE AND DISTANCE.

A ship from latitude 32°.31′ N. sails between the South and East until her latitude is 30°.10′ N., having made 265 miles of Easting. Required her course sailed and distance run.

Solution by Logarithms.

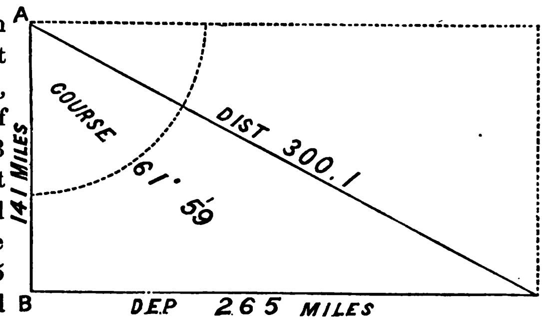
To find the course.

As the difference of latitude, 141 miles ...	Log.	2.14922
Is to radius		10.00000
So is the departure, 265	Log.	2.42325
To the tangent of the course, 61°.59′ ...	Tang.	10.27403

To find the distance.

As radius		10.00000
Is to the difference of latitude, 141	Log.	2.14922
So is the secant of course, 61°.59′	Secant	10.32815
To the distance, 300.1 miles	Log.	2.47737

Solution by Construction.



Draw the meridian A B, and make it equal to 141 miles, the difference of latitude; from B draw C B at right angles to A B, and make it equal to the given departure, 265 miles, join A C, and it is done, for the angle at A will measure, on the line of chords, 61°. 59', and C A will measure 300.1 on the scale from which the the other two sides were measured.

Solution by Inspection.

Enter table 2 with the arguments, departure in its column, diff. lat. 141 in its column, where these two are found to agree, the course will be found at the bottom of the page, and the distance, 300 miles, in the distance column.

PROBLEM 15.

GIVEN THE COURSE STEERED AND THE DIFFERENCE OF LATITUDE MADE GOOD, TO FIND THE DISTANCE AND DEPARTURE.

A ship sails S.E. by E. from 1° 45′ North, and by the next observation she finds that she is in 0° 31′ South. Required her departure and distance.

Solution by Logarithms.

In this case the ship has crossed the equator, therefore the sum of the latitudes is the difference of latitude made good $= 1°. 45' + 0°. 31' = 2°. 16' \times 60 = 136$ miles. Hence,

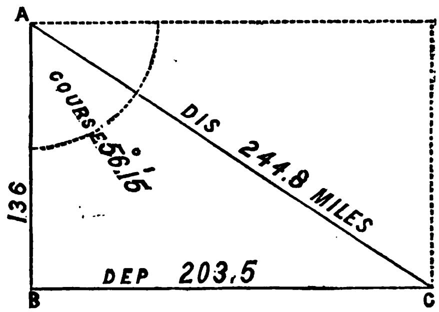
To find the departure.

As radius		10.00000
Is to difference of latitude 136	Log.	2.13354
So is tangent of course = 5 pts...	Tang.	10.17511
To the departure. 203.5	Log	2.30865

To find the distance.

As radius...		10.00000
Is to difference of latitude 136	Log.	2.13354
So is secant of course, 5 points	Sec.	10.25526
To the distance 244.8	Log.	2.38880

Solution by Construction.



Draw A B to represent the meridian, and make it equal to the difference of latitude = 136′, draw also A C indefinitely, making an angle with A B = to the course 5 points. From B, draw C B, at right angles to A B, cutting A C in C and it is done, for A C will measure 244.8, and C B will also measure 203.5 the departure.

Solution by Inspection.

Find the course among the points in table 1, and the departure and distance will be found in their columns abreast of the difference of latitude.

PROBLEM 16.

GIVEN THE DISTANCE SAILED, AND THE DIFFERENCE OF LATITUDE MADE TO FIND THE DEPARTURE AND COURSE STEERED.

A ship sails between the South and West 475 miles, and by observation she has altered her latitude 317 miles. Required her course steered and her departure to the Westward.

Solution by Logarithms.

To find the course.

As the distance 475	Log.	2.67669
Is to radius		10.00000
So is the difference of latitude, 317	Log.	2.50106
To co-sine of the course, 48°. 8′	Co-sine	9.82437

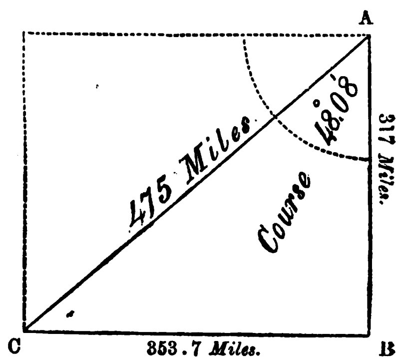
To find the departure.

As radius		10.00000
Is to the distance, 475	Log.	2.67669
So is sine course 48°. 08′	Sine.	9.87198
To the departure, 353.7	Log.	2.54867

Hence the course steered was S. 48°. 8′ W., and the departure made to the Westward was 353.7.

Solution by construction.

Draw the meridian A B, and make it equal to 317 miles. From B, at right angles to A B, draw the East and West line indefinitely. Now with the distance 475 in the compasses, sweep an arc cutting B C in the point C, join C A, and it is done, for C B will measure 353.7 miles, and the angle A, or course, will measure on the line of chords, 48°.08′.



PROBLEM 17.

GIVEN THE DISTANCE AND DEPARTURE TO FIND THE COURSE AND DIFFERENCE OF LATITUDE.

A ship sails in a North Easterly direction from a port in latitude 12°. 10′ South for three days, at the rate of 6 miles per hour, and then finds that she has departed from her first meridian 211 miles. Required her course and present latitude.

Solution by Logarithms.

To find the course.

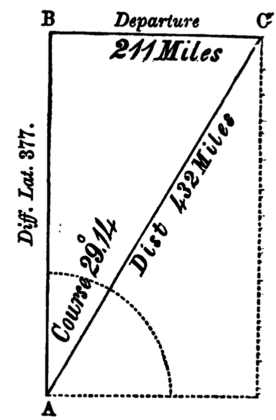
As the distance, 432 miles	Log.	2.63548
Is to radius		10.00000
So is the departure 211 miles	Log.	2.32428
To the sine of the course, N. 29°. 14′ E.	Sine	9.68880

To find the difference of latitude.

As radius			10.00000
Is to the distance 432			2.63548
So is the co-sine 29°. 14′ the course			9.94083
To the difference of latitude	60) 377	=	2.57631
	6.17 N.		
Latitude left	12.10 S.		
Latitude in	5°.53 South.		

Solution by construction.

Draw B C the East and West line, and make it equal to the departure, 211, from the West end B, let fall a perpendicular, A B to represent the meridian. Then with the distance in the compasses = 432 miles; and one foot in C describe an arc, cutting A B in A, and it is done, for A B will measure 377 miles, and the angle A, the course, will measure 29°. 14′ on the line of chords.



PROBLEM 18.

GIVEN THE LATITUDES AND LONGITUDES OF TWO PLACES TO FIND THE COURSE AND DISTANCE BETWEEN THEM.

By middle latitude sailing.

Required the course and distance between a place in latitude 41°.09′ North, and longitude 8°. 37′ W., and another place in latitude 33°. 03′ North, and longitude 16°. 17′ West.

To find the difference of latitude.

Latitude of first place		41°.09′ N.
„ Second place		33°.03′ N.
Difference of latitude, 486 miles	=	8°.06′

To find the difference of longitude.

Longitude of first place	8°.37′ W.
„ second place	16°.17′ W.
Difference of longitude, 460 miles =	7°.40′

To find the middle latitude.

Latitude of first place	41°.09′ N.
„ second place...	33°.03′ N.
Sum of latitudes ... ... 2)	74.12
Parallel being exactly midway between the two places, or middle of the latitudes...	37°.06′ N.

To find the departure by Logarithms.

Say as radius, 90°		10.00000
Is to difference of longitude, 460	Log.	2.66276
So is the co-sine of middle latitude, 37°.12′	Co-sine	9.90120
To the departure 366.4 miles	Log.	2.56396

To find the course.

As difference of latitude, 486	Log.	2.68664
Is to radius		10.00000
So is the departure, 366.4	Log.	2.56396
To the tangent of the course S. 37°.01′ W.	Tang.	9.87732

To find the distance.

Say as radius, 90°	Log.	10.00000
Is to the difference of latitude, 486	Log.	2.68664
So is the secant of course, 37°.01′	Log. sec.	10.09775
To the distance, 608.7 miles	Log.	2.78439

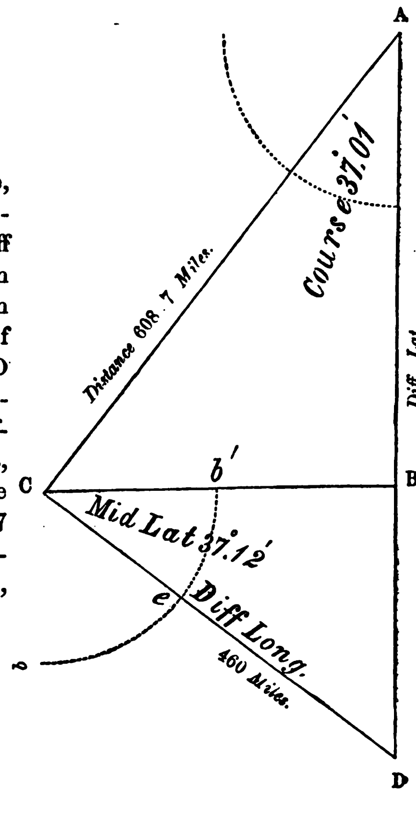
Hence the course from the first to the second port is South 37°.01 West, or S.W. ¾ S. nearly, and the distance 608.7 miles.

N.B. The course thus found is the true course, and in order that the course to be steered by compass should be known, the variation and deviation must be ascertained and applied. Thus if the variation be one point *Westerly*, then the course by compass in the above case would be S.W. ¼ W. But if the variation were *Easterly*, then the

compass course would be S.W. by S. ¾ S. The deviation is to be applied precisely in the same way as the variation. Having the latitude and longitude of the ships, and those of any other place being given, the course and distance to that place are found as above.

Solution by Construction.

Draw the East and West line, C B; with the chord of 60°, describe the arc *b b'*, from *b'* lay off the middle latitude to *e*. Through C and *e* draw the line C D, which make equal to the difference of longitude, 460 miles. From D raise upon B C the perpendicular D B A, make B A = the difference of latitude, 486 miles, join A C, and it is done, for the distance, C A, measures 608.7 and the angle A or course measures 37°.01'; the departure, C B, is 366.4 miles.



PROBLEM 19.

GIVEN BOTH LATITUDES AND LONGITUDES TO FIND THE COURSE AND DISTANCE BETWEEN TWO PLACES.

By Mercator's Sailing.

A ship in latitude 8°.10' N. and 14°.17' W. is bound to a port in latitude 18°.44' S. and 34°.36' East. Required the direct course and distance.

To find the difference of latitude.

Latitude of the ship	8°.10′ N.
Latitude of the port bound to	18°.44′ S.
Difference of latitude in miles ... 1814 miles =	21°.54′

To find the difference of longitude.

Longitude of the ship	14°.17′ W.
Longitude of the port bound to	34°.36′ E.
Difference of longitude in miles 2933 miles =	48°.53′

To find the meridian difference of latitude.

Latitude of ship 8°.10′ meridional parts	190 N.
Latitude of port bound to 18°.44′ meridional parts	1145 S.
Meridional difference of latitude	1335

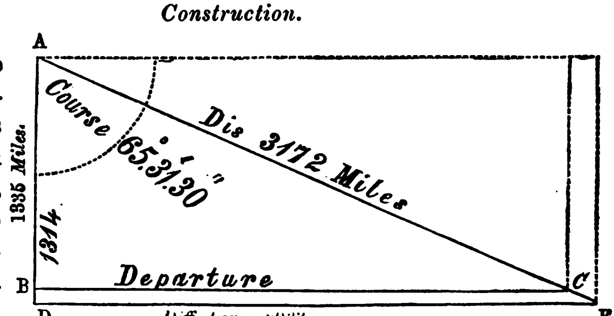
To find the course by logarithms.

As the meridional difference of latitude, 1335	Log.	3.12548
Is to radius	Log.	10.00000
So is the difference of longitude, 2933 ...	Log.	3.46731
To tangent of course, S. 65°.31′.30″ E. ...	Tang.	10.34183

To find the distance.

As radius		10.00000
Is to proper difference of latitude, 1314 miles	Log.	3.11860
So is secant of course		10.38273
To the distance, 3172 miles	Log.	3.50133

Construction.

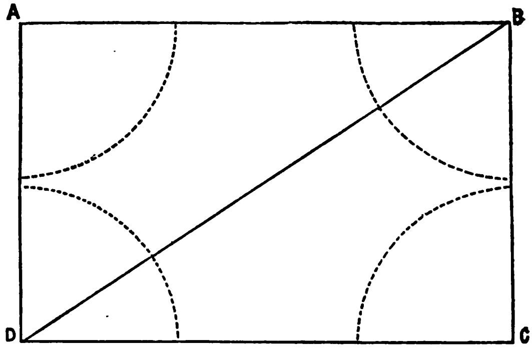


By reference to the construction of this problem, it will be seen that it, like all the foregoing problems, forms a right angled triangle, the base being equal to the difference of longitude *given*, and

the perpendicular equal to the meridional difference of latitude *found*, by adding the meridional parts corresponding to the two latitudes, because the one is *North* and the other *South*. The part of the perpendicular A D used to find the course, being the meridional difference of latitude, the angle which the hypothenuse forms with the perpendicular at A representing the course, and the hypothenuse A C represents the distance. Now, by describing a circle round A B, the proper difference of latitude, we make it radius of that circle. Hence we say as radius is to that side, made radius, so is the *name* of the hypothenuse (which is a secant) to the length of that hypothenuse, or the distance. But to find the angle at A, or the course, we describe a circle round the whole perpendicular representing the meridian difference of latitude, to which circle the difference of longitude becomes a *tangent;* and hence we say as the meridian difference of latitude is to radius, so is the given side to its name (tangent) *of the angle opposite* to it, which is the angle A = the course. Therefore, draw the meridian A D equal to the meridian difference of latitude, 1335, at right angles, there to draw the base D E equal to the difference of longitude, 2933, join A C. Take A B equal the proper difference of latitude, and draw B C parallel to D E, and it is done, for A C will measure 3172 miles, and the angle at A will measure 65°.31′.30″ on the line of chords.

It will be noticed that the sides and angles of any plane triangle necessarily bear a direct proportion to each other—that if a side be lengthened or shortened, the other sides must be shortened or lengthened in the same proportion; therefore if any two sides (or all the sides) be given, the other side and the angles may easily be found by proportion. Again, if a side and an angle, *i.e.*, the difference of latitude and course, or the distance and course, or the difference of longitude and course be given, the other sides may be found, as in the foregoing examples. It is to be borne in mind that in all proportions three things are given to find a fourth. Thus if a side and an angle be given, the other sides can be found, for we have the radius of the tables as the *third* term. It is only necessary to know how to place these terms to obtain a correct result. In all the foregoing solutions it will be found that when the *course* is given radius stands *first* in the proportion, and is compared with the side *made* radius; and when the *course* or angle is sought, the side that is *made radius* stands *first* in the proportion and *radius next*. Let this be remembered. Again, if an angle of a right angled triangle be given, the other angles are known, for as all the angles of any plane triangle, whether right angled or otherwise are equal to *two* right angles, *i.e.*, 180°, it is plain

that if one of the oblique angles of a right angled triangle be known, the other oblique angle is also known, for the right angle remains $= 90°$, and what the known or given angle wants of 90° will be the remaining angle. This will be made plain if we draw a square or parallelogram, whose sides are parallel, and whose angles (four) are right, *i.e.*, each containing 90°. Now draw a line diagonally from B to D, and the figure is divided into two equal parts, the triangles A D B and B C D being equal. But the angles B and D have also been bisected. Now the sides of any triangle are in proportion to the angles opposite to



them, the greatest side being opposite to the greatest angle, and *vice versa.* But as there were four right angles in the whole square or parallelogram, there must be *two* right angles in half of the same figure, as 4 divided by 2 gives 2 for a quotient. If radius be made of the hypothenuse or longest side (or distance), then the base (or departure) becomes the sine of the angle opposite to it (or sine to the course), while the perpendicular (or difference of latitude) becomes the co-sine of the same angle (or the course) and sine of the angle opposite to that perpendicular. If radius be made of the base (or departure), the perpendicular will be the tangent to the angle opposite to it and co-tangent to the other oblique angle, because it is the complement of the former, or what it wants of 90°, and in this case the hypothenuse will be the co-secant of the angle A or the course. If radius be made of the perpendicular, the base will be the tangent of the angle opposite to it (or the course), and the hypothenuse will be the secant of the same angle. The student should construct figures and prove the above for his own satisfaction, and make himself generally and perfectly acquainted with the use of his Gunter's scale and drawing instruments. Let it be remembered that *a given side must be made radius;* that every triangle consists of six parts, *i.e.*, three sides and three angles; that any three (except the three angles) being given, all the rest may be found. A ship cannot sail any distance *in any direction* (except it be due North or South) without forming an angle with the meridian. Should she sail

due East or due West, she forms a right angle, but in any direction *between* the North and East, North and West, South and East, or South and West, she forms a triangle, the portion of the meridian representing the difference of latitude being the perpendicular, the departure from the meridian being the base, and the track made by the ship's keel representing the distance, being the hypothenuse. The distance and course being known, the sine of the course will represent the departure, and the co-sine of the course will be represented by the difference of latitude. In projecting these figures, let it be observed that when a circle is described about the hypothenuse (being a given side) then the other two sides form a right angle with each other *inside of the circle.* Now *sines* and *co-sines form* right angles *inside the radius* circle; while tangents and co-tangents form right angles *outside* of the radius circle. The secants divide parallelograms equally—that is, they pass from the centre (fixed point of the compasses) to the circumference, through which they *pass on* to cut the tangents, forming an oblique angle therewith. These remarks, if carefully studied, will be sufficient to render the solutions of the various cases of plain trigonometry and the various sailings clearly understood.

PROBLEM 20.

GIVEN ONE LATITUDE, THE COURSE STEERED, AND THE DIFFERENCE OF LONGITUDE MADE GOOD, TO FIND THE PRESENT LATITUDE AND DISTANCE RUN.

Four days ago a ship sailed from a port in latitude 41°. 37′ North, and longitude 29°.56′ West, since which she has steered S.E. by S. true, and finds that she is in longitude 26°. 42′ West. Required her present latitude and the distance run.

To find the difference of longitude.

Longitude left		29°.56′ W.
Longitude arrived at		26°.42′ W.
Difference of longitude, miles 194	=	3°.14′

To find the meridional difference of latitude.

As radius		10.00000
Is to the difference of longitude, 194...	Log.	2.28780
So is co-tangent course, 3 points...	Log. co-tang.	10.17511
To meridional difference of latitude, 290.8 ...	Log.	2.46291

To meridional difference of latitude made ... 290.3 S.
Meridional parts for latitude
left = 41°. 37′ ... ... = 2751.0 N.

Meridional parts of latitude in = 37°.54′ N. 2460.7
Latitude left ... ... 41°.37′ N.

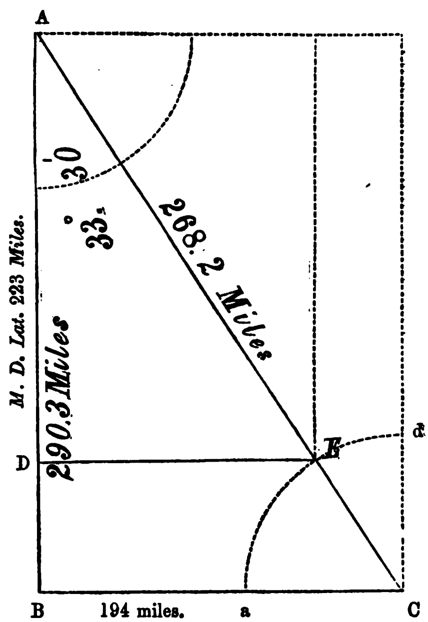
Proper difference of latitude ... 3°.43′ = 223 miles.

To find the distance.

As radius... ... ... 10.00000
Is to proper difference of latitude, 223 ... ... Log. 2.34830
So is secant of course = 3 points ... ... Sec. 10.08015

To the distance, 268.2 miles ... ... Log. 2.42845

By construction.



Draw first the East and West line B C, and make equal to the difference of longitude, 194 miles. Now, with the chord of 60°. in the compasses, and one foot in C describe the arc a d, on which lay off from a toward d, the complement of the course = 56°. 30′ to E. From C through E, draw C A indefinitely. On the point B erect the perpendicular B A, cutting A C in A. Now A B, representing the meridional difference of latitude, will measure 290.3 miles; this being applied to the meridional parts for the latitude left by subtraction, gives the meridional parts for the latitude in. The proper difference of latitude is thus found to be 223 miles, which measure from A to D, draw D E parallel to B C to cut A C in E, and it is done; for A E is the distance = 268.2 miles, and the present latitude = 37°. 54′ North.

QUESTIONS ON THE FOREGOING.

What is latitude?

Latitude is the name given to distance, North or South of the equator, when referred to the earth.

What is meant by the equator?

The equator is a great circle, running East and West, dividing the earth's surface into two hemispheres called Northren and Southren hemispheres.

Why is the equator a great circle?

Because its plane passes through the earth's centre, and because that plane divides the spheres equally, and because the North and South poles are each 90° from it.

How is latitude measured?

Latitude is measured on the *meridian* of any place.

What is a meridian?

The meridian of any place is a great circle passing through the zenith and nadir of that place, cutting the horizon in the true North and South points, and the equator at right angles.

What is the difference of latitude between two places?

The difference of latitude between two places is an arc of a meridian intercepted between the parallels passing through those places.

What is meant by a parallel of latitude?

A parallel of latitude (on earth) is a small circle, which divides the sphere unequally, running East and West parallel to, but every where equally distant from the equator.

What is departure?

Departure is distance, East or West of *any* starting point, forming a right angle, with the difference of latitude, or the meridian departed from.

How is departure measured?

In the same way, and on the same margin of the chart as the difference of latitude, *i. e.*, on the *Eastern* and *Western* margins.

How does the Easting and Westing differ from longitude?

Departure differs from longitude in the same proportion that the *meridian* difference of latitude differs from the *proper* difference of latitude.

What is the proportion?

As the *secant* of the parallels of latitude differ in length, so does the meridian difference of latitude, differ from the proper difference of latitude, and so does the longitude differ from the departure.

What is longitude?

Longitude is distance, East or West from any *first* or *given* meridian.

Where is longitude measured?

On the equator.

What is the difference of longitude between two places?

The difference of longitude between two places is an arc of the equator, intercepted between the meridians of the places, which cut the equator at right angles.

What circles are cut by the meridian of a place besides the horizon and the equator?

All small circles that run parallel to the equator, both North and South, are cut at right angles by the meridian of a place, and also all small circles running parallel to the horizon of that place. All other meridians (every spot on earth has its meridian), are cut by a given meridian, at angles equal to their longitude, these angles being formed at the poles, called horary or hour angles, where all meridians intersect each other.

What is meant by the Zenith and Nadir?

The Zenith and Nadir are the poles of the rational horizon, and 90°. from it in all directions. The pole of the visible horizon is called the zenith, and is that point of the visible heavens which is immediately over our head, and from which if a plummet were let fall, it would pass through the spot on which we stand to the earth's centre, and passing on through the invisible terrestrial hemisphere would reach the nadir, which is the pole of the invisible horizon, and 90° from it.

What is meant by the visible horizon?

The visible horizon is a small circle which limits our view in all directions at sea. The mariner's compass is an artificial representation of the rational and visible horizon, and like them is divided into 360°.

What are the principal parallels of latitude?

Those parallels which are situated at a distance of 23°. 27′ North and South of the equator, called *Tropics,* and those parallels situated 66°. 33′ North and South of the equator called arctic and antartic circles. These parallels divide the *Zones.*

What is meant by the declination of a heavenly body?

The declination means the same with respect to a heavenly body as the latitude of a place on earth, *i.e.,* distance North or South of the celestial equator, or equinoxial.

What is the difference of declination between two stars or other heavenly body?

The difference of declination is an arc of a celestial meridian intercepted between the two parallels of declination passing through those objects.

What is meant by right ascension?

Right ascension in the heavens corresponds with longitude on earth, and is distance (measured on the equinoctial) *East* of the first point of *Aries.*

What is the difference of right ascension between two celestial objects?

It is an arc of the equinoctial intercepted between the meridians passing through those objects.

What is the *first point of Aries.*

That point in the equinoctial which is intersected by the *Ecliptic,* and the equinoctial *Colure,* which is occupied by the sun, on the 21st of March, when his declination is 0°. 0′. 0″, this is called the *vernal* equinox. The opposite point in the equinoctial is intersected by the same *colure,* this point is called the *autumnal equinox.* When the sun's declination again becomes 0.° 0′. 0″. This occurs on the 21st of September.

How many colures are there?

There are two meridians called colures, viz., equinoctial and solsticial colures.

What is the solsticial colure?

That meridian which, intersecting the equinoctial colure at right angles at the poles, passes through the ecliptic at its greatest distance North and South of the equinoctial, or at the point of the sun's greatest declination, cutting the equinoctial at 90° distant from the first points of Aries and Libra. Thus dividing the two hemispheres into eight equal quadrants, four on each side of the equator.

Explain the meaning of the equinoctial colure?

The equinoctial colure is that meridian which cuts the solsticial colure in the poles at right angles, and also the equinoctial in the first points of Aries and Libra. When the sun occupies this point the days and nights are equal, as the sun has then no declination.

What is meant by the ecliptic?

The ecliptic is a great circle, on which the sun appears to travel in his annual revolution, or in the earth's revolution round the sun. This great circle cuts the equinoctial in the first points of Aries and Libra, and forms an angle with it, equal to the sun's greatest declination, equal to 23°.27′.

What is this angle called?

The obliquity of the ecliptic.

What is the latitude of a heavenly body?

The latitude of a heavenly body is an arc of a circle of celestial longitude intercepted between the ecliptic and a parallel of celestial latitude passing through that object, and is called North or South latitude, according to the situation of the object with regard to the ecliptic.

How far are the poles of the ecliptic removed from those of the equinoctial?

The poles of the ecliptic are situated at a distance from those of the equinoctial, equal to the obliquity of the ecliptic, viz., 23°.27′.

What are circles of celestial longitude?

Circles of celestial longitude are great circles intersecting each other in the poles of the ecliptic and cutting the ecliptic at right angles, in the same manner as the meridians cut the equinoctial.

What is meant by azimuth circles?

Azimuth circles are great circles intersecting each other in the zenith and nadir. These circles cut the horizon at right angles, and their values are referred to the horizon on which they are measured, the azimuth angles being formed at the zenith. They are also called *vertical circles.*

What is meant by the prime vertical?

The prime vertical is that circle which is 90° from the meridian, counted on the horizon, and, therefore, cuts the horizon in the true East and West points, and consequently at right angles with the meridian.

How many azimuth circles can be drawn upon a sphere?

As many as there are points in the horizon.

What is the sun's azimuth?

The azimuth of the sun, moon, star, or planet is the angle formed at the zenith by the meridian of the place, and a vertical circle passing from the zenith through the centre of the object to the horizon on which it is measured.

What is an amplitude?

An amplitude is an arc of the horizon intercepted between the prime vertical, or true East and West points, and the centre of a heavenly body at rising or setting, and is found by multiplying the *secant* of the latitude of the place by the *sine* of the declination of the object.

How many amplitudes of the same object can be taken in the same day?

Two; one at rising and another at setting.

What is the altitude of a heavenly body?

The altitude of a heavenly body is an arc of a vertical circle passing from the zenith through the object, the *altitude* being intercepted between the centre of the object and the horizon.

What is the complement of that altitude, and what is it called?

The complement of the altitude is what it wants of 90°. It is intercepted between the centre of the object and the zenith, and is hence called the zenith distance.

On what circle is the sun, at noon, in any place?

On the meridian of that place?

What do you measure when the altitude is taken at noon?

I measure the arc of the meridian intercepted between the centre of the sun and the horizon; hence this is called the *meridian altitude*, or the height of the sun on the meridian above the horizon.

Why are meridian altitudes necessary in navigation?

Meridian altitudes furnish an easy method of finding the ship's latitude (or distance from the equator), for, having the *altitude*, we have also the zenith distance; and knowing the sun's (or other object's) distance from the zenith, and also from the equinoctial, we easily find the distance of the *equinoctial from the zenith*, which is *equal to the latitude.*

Will the *observed* altitude of a heavenly body, taken from 90°, give the *true* zenith distance of the object?

No; the altitude *observed* must be corrected for errors arising from the *height* of the eye of the observer, called *dip* (always subtractive), and for *refraction* (also subtractive), for the semi-diameter (*additive* when the lower limb is observed, but subtractive when the upper limb is observed), and for paralax always additive; and should the instrument have an error, this must also be applied. These corrections being made to the observed altitude, the *true* altitude is obtained, which being subtracted from 90° will give the *true zenith distance.**

PROBLEM 21.

A DAY'S WORK.

A ship from latitude 36°. 17′ North, and longitude 41°. 34′ W., sails as in the following table. Required her present latitude and longitude. (The height of the eye in this ship is 18 feet.)

* All altitudes must be corrected for dip, refraction, and paralax; but the stars have no sensible semi-diameter or paralax.

H	K	F	Courses.	Winds.	Lee way	Remarks. April 4th, 1864.
1	7	4	E.S.E.	N.E.	1	First part strong winds with heavy sea.
2	7	4	"		"	Latter part more moderate, made all
3	6	6	"		"	sail.
4	6	6	"		"	Meridian alt. sun's lower
5	6		"		"	limb ... ... 60°.49'.00"
6	6		"		"	Dip for 18 feet ... — 4.11
7	5	4	S.E.	E.N.E.	"	60.44.49
8	5	4	"		"	Refraction ... ... — 32
9	4	6	"		"	60.44.17
10	4	6			"	Paralax ... ... + 04
11	4		S.S.E.	East	"	
12	4		"		"	60.44.21
1	4		S. by E.	E. by S.	1¼	Semi-diameter ... + 16.01
2	4		"		"	True central altitude 61.00.22
3	4		"		"	Subtract from ... 90.00.00
4	4		"		"	Leaves correct zenith dis. 28.59.38 N.
5	4	5	S. by E.		1½	Declination corrected... 5.56.47 N.
6	4	5	"			
7	4		"		"	True observed latitude. 34.56.25 N.
8	4		"		"	Thermometer at noon ... 60°.00'
9	4		"		"	Do. midnight ... 56.00
10	4		"		"	Barometer 29.61
11	4		"		"	Do. midnight ... 29.50
12	4		"		"	Variation 1¼ points Westerly.

(For construction see fig. page 35.)

Course S. 37°. 45' E.	Distance 104 miles.	Diff. lat. S. 82 m.	Dep E. 63.8	Lat. by acct. N. 34°. 55'	Latitude Obs. N. 34°56'24"	Diff. lng. E. 1°. 18'	Long. by act. 40°. 16'.	Long. by Luna.	Long. by Chr. 40°. 13' W.

Courses carrd	dis	N	S.	E.	W.
E.S.E.¼E.	40		13.5	37.7	
S.E.¼E.	20		13.4	14.8	
S.S.E.¼E.	8		7.2	3.4	
S. by E.	16		15.7	3.1	
S.¾E.	33		32.6	4.8	

Diff. lat. 82.4 63.8dep.

The courses being corrected for lee way and variations, will stand as in the adjoining traverse table. Then with the difference of latitude and the departure we find the course to be S. 37.45 E. and the distance 104 miles, by the rule laid down on page 10, and having the two latitudes and the departure, we proceed to find the difference of longitude.

To find the difference of longitude.

Yesterday's latitude... ...	36°.17'.00" N. meridional parts	2339
Difference latitude made ...	1.22.24 S. = 82.4 miles.	
Latitude in	34.54.36 N. meridian parts	2238
Meridian difference of latitude		101

As radius		10.00000
Is to meridian diff. lat. = 101 miles...	Log.	2.00432
So is tangent course, 37°. 45'	Tang.	9.88890
To the difference of longitude ÷60) 78.20		1.89322

	1°.18'.12" E.
Yesterday's longitude	41.34.00 W.
Longitude in to-day	40.15.48 West.

Supposing the ship to be bound for Bermuda. Required the direct course and distance thereto.

Latitude of Bermuda,	32°.08'.00" N. meridional parts,	2038
Ship's latitude	34.56.25 N. " "	2239
Proper diff. lat. 168.3 =	2.48.25 meridional diff. lat.	201

Longitude of Bermuda	64°. 50' W.
Longitude of ship	40 . 16 W.
Difference of longitude 1474 miles... =	24.34

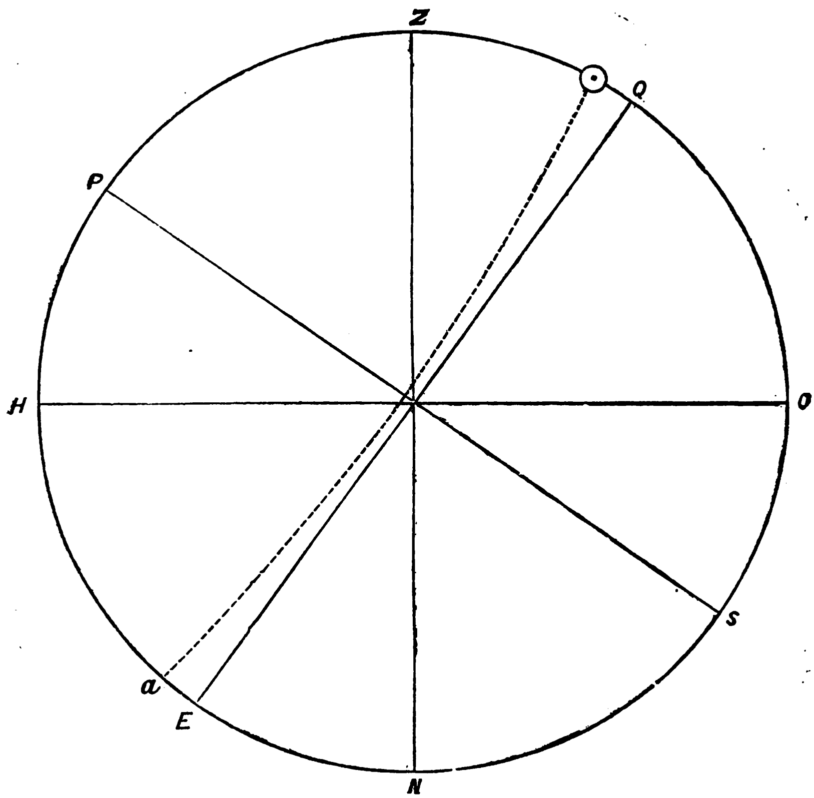
To find the course.

As meridional diff. lat. = 201 miles	Log. 2.30320
Is to radius	10.00000
So is the diff. long. = 1474	Log. 3.16850
To the tangent of course S. 82°. 14' W.	Tang. 10.86530

To find the distance.

As radius	10.00000
Is to proper diff. lat. = 168.3	Log. 2.22608
So is secant of course 82°.14'	Secant. 10.86922
To the distance = 1245 miles....	Log. 3.09530

To find latitude by construction.



With the chord of 60° describe the primitive circle Z H N O to represent the meridian of the place of observation. Through the centre draw the horizon H O and the prime vertical Z N. With the chord of the *true* altitude of the sun, in the compasses, and one foot in O, lay off towards the zenith Z the altitude at ☉; now the sun's declination being corrected, take its chord in the compasses, and place one foot in the ☉, the other laid on the primitive circle will point out the place of the Equator, (in this case, the declination being North, the Equator is South of the sun,) at Q. Draw the Equator E Q, and at right angles thereto the axis P S; describe also the parallel of declination, *a* ☉, and it is done, for Q Z expresses the latitude, which, taken in the compasses and applied to the line of chords, gives 34°. 56′. 25″, and it is North because the zenith is North of the Equator.

THE LEAD LINE.

The lead line is usually marked as follows, viz.:—

At two	fathoms	...	Two thongs of leather.
„ three	„	...	Three „ „
„ Five	„	...	White rag.
„ Seven	„	...	Red „
„ Ten	„	...	A piece of leather with a hole in it.
„ Thirteen	„	...	Blue rag.
„ Fifteen	„	...	White „
„ Seventeen	„	...	Red „
„ Twenty	„	...	A piece of marline with two knots.

The deep sea line is similarly marked to twenty fathoms; at every additional ten fathoms a piece of marline with an additional knot, and a bit of leather may indicate each intermediate five fathoms.

The hand lead line should be measured before using it, and the lead and line (bent) be kept always at hand ready for use, whenever the ship is in "pilot water," viz., less than twenty fathoms.

THE LOG LINE.

The principle of the log line is, that the length of each KNOT shall bear the same proportion to a nautical mile that the seconds run by the glass do to an hour. Now as a nautical mile contains 6,080 feet, and an hour 3,600 seconds, we have as 3600 : 6080 : : 30 : 50 ft. 8 in., which is the proper length of the knot for a 30 second glass, but glasses generally run but 28 seconds, which will give 3600 : 6080 ft. : 28 : 47 feet 3 inches.

The nautical mile is, however, generally reckoned to contain 6000 feet, then the rule is as 3600s. : 6000 ft. : : 28 : 46 ft. 8 inches. But if 30 seconds give 50 feet, then 6 seconds should give 10 feet; hence as 6s. : 10 : : 28 : 48 feet 8 inches. Hence the *practical rule.*—Annex a cipher to the seconds run by the glass (be they more or less than 30s.), and divide by 6, calling the quotient feet and inches, which will give the proportionate length of the knot.*

THE ADJUSTMENT OF THE QUADRANT.

The adjustment of the quadrant or sextant consists in, first, setting the plane of the index-glass perpendicular to the plane of the instru-

* It is plain that this is a most uncertain method of determining a ship's distance, as no two officers will make the same distance by the log. The seaman's eye is the best log next to Massey's patent.

ment; and second, to set the horizon-glass perpendicular to the plane of the instrument, and at the same time parallel to the plane of the index-glass, all of which are done by the proper use of screws placed in connexion with those glasses for that purpose. A half-hour's instruction by a man who understands the instruments is worth a volume of written instructions. (See the Epitomes on this subject.)

MERCATOR'S CHART.

1st. The *Meridians* are those lines which run parallel to each other from top to bottom, or from North to South on the Chart, and are at right angles to the Equator; those meridians on the right and left of the chart are called the graduated meridians, because they are divided into degrees and minutes.

2nd. The *Parallels of Latitude* are parallel lines from side to side of the chart, that is, from West to East, and are parallel to the Equator; those parallels at the top and bottom of the chart are called *graduated parallels*, because they are divided into degrees and minutes.

To prick off a ship's place on the chart, the latitude and longitude being given.

Apply the edge of the parallel ruler to the parallel of latitude on the chart, which is nearest to the given latitude, and move it until it reaches the given latitude; then with the compasses take from one of the *graduated parallels* the difference between the given longitude and that of the meridian, whose longitude is nearest to it. Set this off along the edge of the ruler from the point where the meridian intersects the edge of the ruler, in the same direction as the given longitude is from the meridian, and this will be the ship's place.

To find the course from the ship to any place, or the course from one place to another.

Lay the edge of a parallel ruler over the given points, and move the ruler in the usual way until that edge comes to the centre of the nearest compass drawn on the chart, the edge of the ruler will point out the course on the chart, which will be the *true* course, if the chart be a general one; and the compass course is found by applying the variation in a contrary manner to the general rule.

PRINCIPLE OF THE MERCATOR'S CHART.

If we conceive a globe, on which all the meridians, parallels, equatorial circles, ecliptic, zodiac, and all the stars in their proper positions

with respect to the poles and the Equator, *raised*, and coated with printer's ink; now suppose this globe to be placed in a cylinder, with the Equator in contact with the sides of the cylinder—that is, that the diameter of the globe and cylinder shall be equal; let the globe be of india-rubber or other substance capable of being expanded by inflation. Inflate the globe until it fills the cylinder, the globe opening at the poles, so as to reach the ends of the cylinder; this being done, cut the cylinder open, and on spreading it out you will have the celestial plenisphere on Mercator's projection. The Mercator's terrestrial chart may be formed in the same way, by having all the meridians, parallels, coasts, seas, islands, &c., painted on the globe with printer's ink. Hence lands, seas, islands, and space generally are distorted as we approach the poles, and this distortion increases as the *secants* of the parallels of *latitude* increase.

PROBLEM 22.

To find the time of high water.

Required the time of high water at Charleston (S.C.) on the 1st of September, 1864.

		H.	M.	S.
☽ 's meridian passage at Greenwich, Sept. 1st, 1864...		0	8	6
Correction for longitude 79°.54′ (80) = West... ...	+		11	0
☽ 's meridian passage at Charleston (S.C.), 1st Sept.		00	14	6
Establishment of the port of Charleston		7	13	0
Time of high water 1st Sept., P.M.		7	27	6

Required the time of high water at St. Francisco, California, on the 21st of December, 1864.

		H.	M.	S.
☽ 's meridian passage at Greenwich, Dec. 21st... ...		18	37	30
Correction for longitude, 122°.21′ W.	+		16	24
☽ 's meridian passage at San Francisco, 21st Dec. ...		18	53	54
Establishment of the port of San Francisco		12	06	00
Reject	= 24 —	30	59	54
Time of high water at San Francisco, Dec. 21st ...		6	59	54

This method of finding the time of high water is not at all times absolutely correct, on account of the inequality of the lunitidal interval, but it will not only be found sufficiently correct for all practical purposes, but as much so as most other methods; and all practical men know that half an hour's difference in the time of high water may arise at any time from the direction and strength of the wind.

PROBLEM 23.

To find the variation of the compass by amplitudes.

Required the sun's true amplitude at setting, in latitude 39° North, and longitude 41°. 45' West on the 21st day of September, 1864, the magnetic amplitude (or bearing of the sun's centre by compass) being West 16°. 52' towards the N.

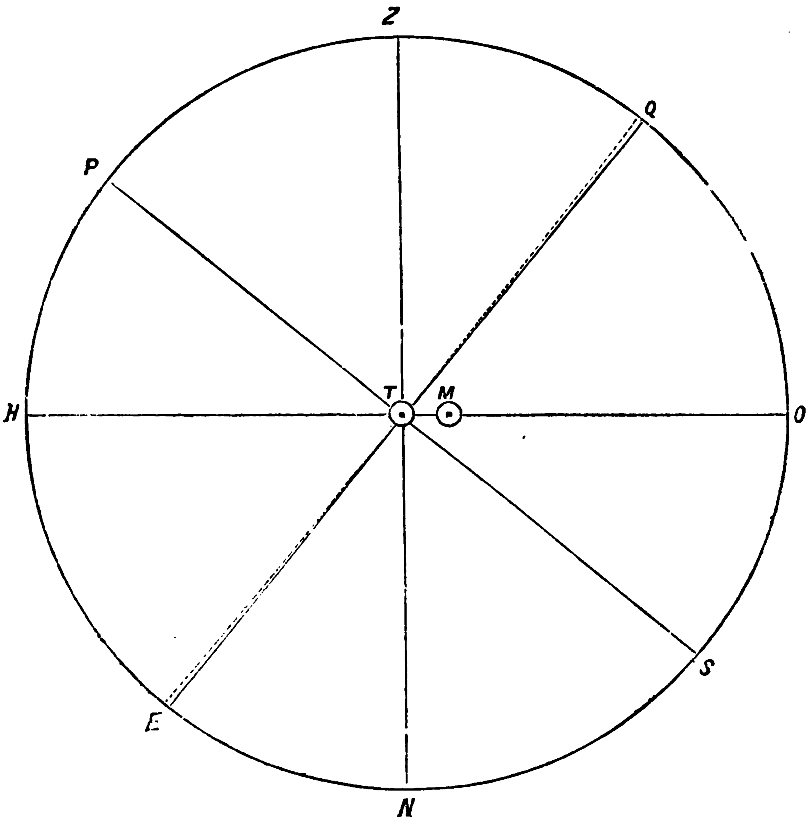
Sun's declination at noon, Sept. 1st, 1864 is	00° 30' 28" N.
Correction for longitude 41°.45' = 2h.47m. × 58s.4 —	2.42
Sun's correct declination at noon, Sept. 21 at ship ...	00. 28.46
The sun set at six o'clock on the 21st, correct for 6h. × 58s.4... ... ... —	5.50
Sun's true declination at setting...	00.22.56 N.

Latitude 39°.00' North...	Log secant.	10.10950
Sun's declination at setting 22' 56"	Log sine.	7.82419
Sun's true amplitude, West, 29'.31" N. ...	Sine.	7.93369
Magnetic amplitude, W. 16°.52'.00" N. ...		

Variation ... ... 16°.22'.29" Westerly because the true bearing lies to the left of the magnetic.

Construction.

With the chord of 60°. describe the primitive circle, Z P H E S O Q to represent the meridian, draw the horizon H O, and the prime vertical Z N. In this, as in all other cases of amplitudes, the latitude is given. Then with the chord of the latitude in the compasses, and one foot in H, extend the other towards Z, the place of the pole will be shown as at P; draw the axis P S, and at right angles thereto, the equator E Q. Lay off from E and Q the sun's declination, represented by the dotted line, which in this case is only 0°. 22'.56" North, therefore the sun's place in the horizon at setting is nearly due West at



$\overset{T}{\odot}$ which is 0°.29′.31″ North of the due West. But the sun bears by compass West, 16°.52′.00″ North, this measured on the semitangents places the sun at $\overset{M}{\odot}$ at setting and at rising, hence 16°.52′ less 0°.29′.31″ is the variation, or error of the compass, and it is *West*, because the true amplitude is to the left hand of the magnetic.

Example 2.

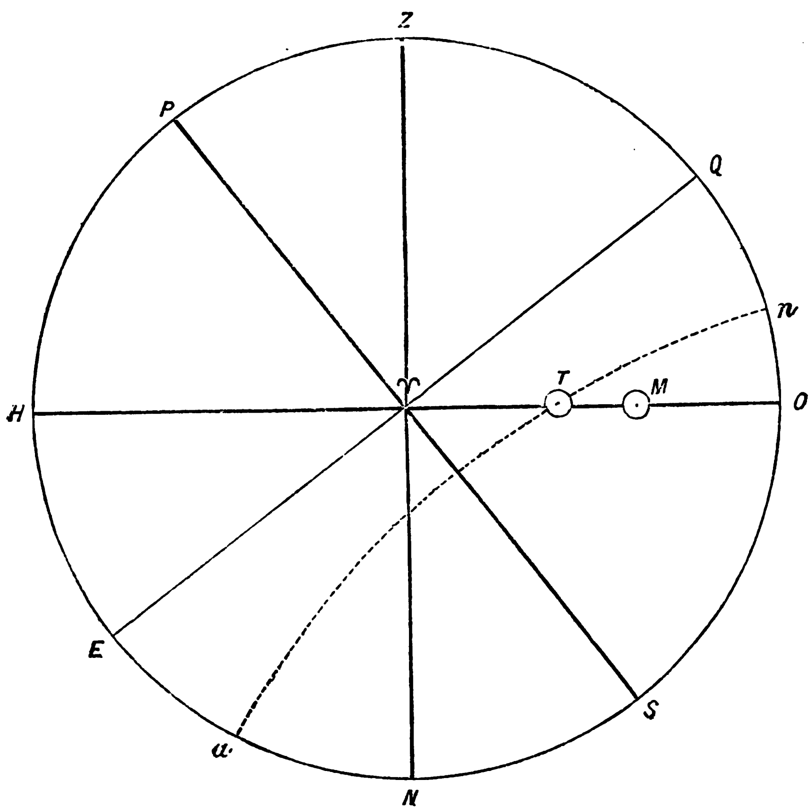
Required the sun's true amplitude at rising, in latitude 51°.31′ N., and longitude 60° West, on the 21st of December, 1864, and the variation of the compass; the magnetic amplitude being E. 62°.15′ S.

	H. M.
Sun rises (Greenwich time) 21st of December	20 06
Correction for longitude 60° W.	+ 4.00
Time at Greenwich when sun rises December 21st, in longitude 60° W....	00 06

Sun's declination, Dec. 21st, at noon, G. T....		23°.27'.17" S.
Correction for 6m. (past noon)		00.00
Sun's correct declination at time of sun rising		23. 27. 17 S.

Latitude of ship	51°.31'.00"	... ...	Secant	10.20601
Sun's declination	23. 27. 17 S.	... ...	Sine.	9.59986
Sun's true amplitude E	39.45 S.	... ...	Sine.	9.80587
Magnetic amplitude E	62.15 S.			

Variation ... ... 22°.30' West because the true amplitude is to the left hand of the magnetic, and this shows the error of the compass for all causes, so long as the ship's head is on the same course as it was when the amplitude was observed.



QUESTIONS ON THE DUTIES OF SECOND MATE.

What are the duties of second mate ?

A second mate's duties are, of all the officers, the most difficult to perform, especially when there is no third mate or boatswain.

Why so ?

Because he is the connecting link, or the bridge over that great gulf which ever exists between the quarter-deck and the forecastle, and is supposed to do all the duties of boatswain and third mate when there is neither of these on board; and at the same time to keep his high position as an officer and a gentleman. Besides which he has his own proper duties to perform.

What are the duties of his own proper office as second mate ?

The second mate has charge of the ship in the starboard watch; must keep the ship's way, and mark the log board; work the after part of the ship, and attend to the mate's orders as to the *head braces*, even when the captain is on deck; and when the chief officer is not on deck the second mate takes his place forward in working the ship. He has charge of log and lead lines and their measurements, of all boat fittings, of the stowage of all sails and stores, of preparing the hold to receive cargo, clearing the limbers, laying dunnage, placing mats, &c., also of stowing the cargo, and breaking it out and slinging it. He has charge of unloading all boats that may come alongside during the night; he is not permitted by the duty of his office, to sit down *at all* during his watch on deck, nor will any good second officer permit himself to do so at any time during his watch on duty by day or night.

Where does the second mate mess ?

In the cabin, in all well regulated ships. Sometimes, however, he is compelled to mess with the third mate and boys; this, of course, no spirited young man will submit to, unless his mess-room is properly fitted up. In large steamers all the officers have proper cabins allotted to them.

How far is the second mate responsible for the cargo ?

As far as his wages extends, but no further.

How does the second mate become responsible for damage of the cargo ?

If it be made to appear that any package has received damage through neglect, bad stowage, want of the proper amount of dunnage, &c., the second mate, having had full charge of stowing the hold, would be liable for the damage thus sustained to the amount of his wages for the voyage.

If stevedores were employed, who then would be responsible?

The employment of stevedores does not relieve the ship from the liability, and the second mate, having charge of the hold, should *see* that the stevedores do their duty; and, if he neglects this, he is personally liable.

What further is it necessary for the officer of the hold to observe with regard to the stowage of casks and bales?

That crowbars be not used in stowing casks, nor hooks in the stowage of bales of fine goods.

Why should crowbars and hooks not be used for the purpose of stowing casks or bales?

Because a crowbar will start a head or a stave more readily than a handspike, and hooks often ruin fine goods, by entering many parts through the packing, and the shipper in consequence is the sufferer, if it cannot be proved that the damage was received on board; but if this can be proved, the ship is clearly liable. Hooks may be used with cotton, wool, jute, hemp, &c., &c.

What is the first duty of the second mate, or officer having charge of the hold, in stowing a ship's cargo?

The first duty of the officer who has charge of the proper and safe stowage of a cargo should be to have the "limbers" raised, and see that they are clear. In some ships the skin is calked, rendering this precaution unnecessary, but where the skin is open and there are limber boards it should never be neglected.

Why is this necessary?

Because grain, beans, seeds, small coal, chips, &c., are liable to fill up the berthings between the floors and to choke the limber holes (water course), and the bilge water, not having free course to the pump-well, would rise above the ceiling and damage the cargo.

How often should the limbers be thus cleared?

They should be cleared out before the dunnage is laid for each cargo, if the former cargo consisted of any bulk cargo, such as grain, seeds, beans, coals, or sand ballast.

What is dunnage?

Pieces of wood or boards laid on the ship's skin to keep the cargo from being wet with salt water.

How much dunnage is required?

Eight to twelve inches in the bilges, seven to ten inches at the kelson, and two inches all the way up the sides. Sharp ships require more at the kelson.

How should the lower tier of dunnage be laid on the ship's skin?

Athwart ships in the *bottom*, and *up* and *down* in the wings, and up, the sides.

Is wood always used for dunnage?

No; bamboos, rattans, horns, hoofs, logwood, fustic, lignum vitæ, or any kind of *cargo*, that will not take damage, may be used, with the consent of the shipper.

Is there any part of a ship's hold that requires more dunnage than another?

Yes, the bilges, about the masts and pump, will require more dunnage than the sides of the vessel.

Why do the bilges require more dunnage than part of the floor?

In flat ships more dunnage is required in the bilges, because, when the ship lies over, all the water in the hold will collect in the lee bilge and may rise higher than it can in any other part of the hold.

Is there any other part of a ship's hold that requires special care in stowing cargo?

Yes, along the forecastle bulk-heads and the lower corners of wing bales.

Do all ships stow their cargo by this rule?

No; but the law of insurance requires this rule to be observed, and when it is not, the underwriters will not be liable for damage by salt water.

What is meant by *stowing* cargo?

Arranging bales, cases, casks, barrels, packages, &c., in such a manner that they shall occupy the least possible space, and that they shall be perfectly free from damage by salt water, or by proximity or contact with each other.

What is a bale?

A square package sewed up in canvas, and secured by hoops and lashings.

What is a case?

A box square or having parallel sides, secured by hoops or battens.

What are casks?

Wooden vessels made of hoops, heads, and staves; those made to contain fifty or sixty gallons are called *casks;* such as contain thirty or forty gallons are called barrels; large casks are called hogsheads, tierces, butts, pipes, &c.

Do all cargoes consist of bales, cases, or casks, &c.?

No; cargoes often consist of (besides bales and cases, casks, &c.) bags, packages, merchandise in bulk, and many other kinds.

What would you designate a package?

That which is neither bale, case, bag, barrel, cask, tierce, pipe, or

butt; such as a plough in matting, carriage wheels, or a bundle of bacon.

What do you mean by a "bulk" cargo?

Coal, corn, salt, rice, beans, guano, &c., &c., stowed loose in the hold without package of any kind.

How are such cargoes preserved from damage by salt water?

By dunnage, over which canvas or mats are laid, but coal requires no dunnage on short voyages, though on long voyages every precaution should be taken to keep coal from contact with water, as moisture assists in producing spontaneous combustion.

Which of all these requires the most dunnage?

Guano.

Why so?

Because if guano be not well dunnaged it will absorb the water as fast as it gets into the hold, and the ship will become deeper and deeper though there is no water in the pump well, and may compel a jetison, or sink the ship.

What is it necessary to do before taking in bales, cases, and casks, or other cargo?

It is generally necessary to measure them, and always to examine them, to see that the bales and packages are in good order, and that the cases are strong, and the casks, &c., tight, strong, and full to the bung.

What do you mean by measuring a bale or a case?

To measure with a scale or "callipers," the length, breadth, and depth, in feet and inches, and to enter these measurements *with the* mark and number of the *bale, case,* or *package,* in the cargo book, with the name of the shipper.

Why is this done?

To ascertain the contents in solid measure.

Why is it necessary to ascertain the solid contents of cargo?

Because the freight is generally payable by the ton measurement.

What is a ton measurement?

Forty cubic feet.

What is a cubic or square foot?

Seventeen hundred and twenty-eight square or cubic inches.

What is a square inch?

A cube, the outer surface of which contains six plane or superficial inches square.

How can you ascertain the solid contents of a bale or case?

By multiplying the length by the breadth, and this product by the depth.

Is it necessary to take an account of *all* the cargo that is received on board?

Yes.

How are accounts of cargo kept?

The marks, numbers, measurement and descriptions are entered in a cargo book, with the names of the shippers and consignees.

What do you mean by a consignee?

The person to whom the goods are consigned or sent.

What do you mean by the shipper?

The person who sends the goods on board.

How is one bale or package distinguished from another?

By its mark and number, as well as its description.

How are bulk cargoes described?

By their respective names, such as coal, corn, beans, wheat, guano, flax-seed, hemp-seed, oats, &c.

How much dunnage would you use with casks of liquids, oil, &c.

None; all that is required is two beds under each cask in the ground tier, sufficiently stout or thick to keep the bilge of the cask free of the ship's skin.

Where would you place those beds, and how?

Athwart ships, under the quarters of the casks.

Is a cask properly stowed with those beds alone?

No; chocks and quoins are necessary.

What do you mean by chocks?

Short billets of wood driven into all the openings between the casks, and between the ship's sides and the wing casks.

Which are the wing casks?

Those that are next to the sides of the vessel.

What do you mean by the ground tier?

The first tier or row that is laid in the hold.

What are the other rows called?

Second, third, fourth, and top, or upper tiers.

Is it proper to stow dry goods immediately on the top of liquids, oils, &c.

No; there should be wood, planks or double matting placed between all liquids, and *planks and matting* between oil and dry goods.

How should a bulk cargo of corn, wheat, oats, &c., be stowed?

On the proper quantity of dunnage, with a covering of mats, and should be well punched down and rolled with some heavy weight, such as a cask full of water or a heavy roller.

Why is it necessary to roll such cargoes?

To prevent them from settling with the ships' motion when at sea.

Why is it desirable that the cargo should not settle?

Should the cargo settle down it would then have room to "fetch way," and would, in that case, endanger the ship.

What other precautions would you use to prevent a cargo of corn, wheat, linseed, hemp-seed, &c., from fetching way?

Bulkheads and shifting boards may be used, and are used in most cases.

What is a bulkhead?

A partition running athwart the vessel's hold from side to side.

What are shifting boards?

Shifting boards are partitions which run fore-and-aft from stancheon to stancheon, and extend, in some cases, from the kelson to the deck.

How should a ground tier of casks containing liquids be stowed?

Casks of liquids should be stowed fore-and-aft, bungs up, bilges free, chime to chime, and bilge and cantline.

Is it proper to stow oil, beer, cheese, lard, bacon, butter, fish, hams, &c., *among dry* goods?

No; this kind of goods should be stowed by themselves, or under all damageable goods; they may be stowed over liquids.

Should there be dunnage laid on the between decks?

Yes; two inches for bales and one inch for cases.

How should this dunnage be laid?

Athwart ships, to allow a free water-course.

How are bales of cotton, hemp, wool, jute, &c., stowed?

Cargoes of this kind are pressed, and forced together into the smallest possible space by screws.

Against what are the screws placed for this purpose?

Against uprights placed against the beams and secured in various ways at the lower ends.

What are these uprights called?

Sampson posts.

In using screws in the hold is it necessary to use oil?

It is thought to be necessary, but it should never be permitted.

Why not?

Because oil or grease of any kind, especially linseed oil, will ignite cotton, jute or hemp, under a pressure, by spontaneous combustion.

What would you use instead of oil?

Soft soap.

When a tier of bales of cotton or wool is laid, how would you put another bale into the same tier?

By entering two planks, called skids, between two of them, and forcing them open at the outer ends far enough to receive the extra bale, which is then forced in by screws.

Would you grease the skids or not?

Grease or oil should not be used; soft soap might be used to advantage if the pressure is great.

What is it necessary to observe in laying a ground tier of bales or cases?

1st, That there is sufficient dunnage, especially at the "wing corners." 2nd, That heights are preserved, that a tier may not be lost, or that "broken stowage" be not made on the top of the cargo. If the cargo be cotton, wool, hemp or jute, height may be "screwed for."

In stowing a full cargo of tea, what should be observed in commencing the stowage of the cargo?

The hold should be measured for "longers," "heights," and "breasts," and a perfect level maintained from the commencement. Every tier should be perfectly square, athwart the hold, and a true perpendicular preserved.

What is to be observed in the wings?

Two inches of dunnage, placed up and down, and a double mat between the tea chests and the dunnage.

What do you mean by broken stowage?

Space at the ends of, or above the cargo, which is filled with small packages or other small goods.

In stowing the top or upper tier, what should be observed?

That a mat be placed between the upper deck and the upper tier.

Why is this precaution necessary?

Because the sweat or steam of the hold often accumulates on the under part of the deck, and may drip down and damage the cargo.

Should there be mats between the cargo and the thwart-ship bulk-head?

Yes.

In closing the hatches, what is necessary to be observed?

That they are well and properly secured, so that water cannot enter.

How is this to be done?

By calking down the hatches, and by nailing over them three tarpaulings secured by means of battens.

What are these battens made of?

Any hard wood, sometimes iron.

What would you do with broken stowage in timber cargoes?

I would fill it with staves, treenails, &c., if they could be obtained.

What is generally used to "trim the tiers" in stowing tea and other small cases?

Large mallets, called commanders.

Are these useful in the stowage of other cargoes ?

Yes ; in stowing cargoes of rice, flour, sugar, or part of a cargo of guano in bags, they should be used to press and level the tiers.

How would you stow a cargo of railroad iron ?

First diagonally athwart the kelson from port to starboard, the tiers or rails three feet apart, taking care to have the ends resting against strong planks ; then diagonally from starboard to port, at the same distance apart, securing the ends in the same way, thus making a kind of grating, and so continue to lay the tiers alternately from port to starboard, or each fifth tier may be laid fore-and-aft.

How far forward and how far aft would you lay the tiers ?

The tiers should be commenced well, or quite forward and aft, and tapered as the tiers rise, so as to have but one "longer" for the last four tiers on the top.

Why should you stow this description of cargo in this way ?

In order to raise the weight as much as possible in the ship, and that the main centre of the weight shall be immediately under the ship's centre of rotation.

Why is this desirable ?

Because if the dead weight of the cargo be fore-and-aft, or too low in her, she will labor heavily in a sea-way, whereas if the weight be brought *up* in the centre of rotation, this kind of cargo may be carried as "comfortably" as any other.

How would you trim ballast for the passage ?

Ballast should be stowed like all other dead weights, tapering from forward and from aft, to a ridge athwart the hold, the vertex of that ridge being immediately under the ship's centre of rotation.

What do you mean by the ships centre of rotation ?

The point around which the ship turns when "in stays," and on which she balances when "pitching" and "sending."

How would you stow logwood, camwood, fustic, &c. ?

I would first stow, as closely as possible, a full tier up to the deck, and then, selecting the straightest pieces, I would drive them into the tier with mallets until no more could be driven.

How would you stow a cargo of dry hides ?

I would stow a full tier up to the deck, and then by means of a "stevedore," force in more hides, until it is found impossible to get any more in.

By what means are these extra hides forced into the tier ?

By a stout plank, made quite thin and smooth at one end, and stout

at the other like a bakers shovel, and blocks or screws are used as a purchase.

How are salted hides stowed?

In various ways; sometimes they are bundled, and used as broken stowage, with casks of tallow, &c.; again, they are spread out in the hold, with a layer of salt between each pair of hides, stowing them hair to hair and from side to side. If there be a full cargo of wet hides they should be raised up in the middle as much as possible, consistently with their solidity and security.

Where would you stow bones, hoofs, and horns, if offered with a cargo of hides and tallow, the latter being in casks or cheroons?

They should be stowed as dunnage as far as possible, and to fill up vacancies at the ends, sides, and between the casks and cheroons; in all the "breaks," near the beams and knees, in order that they may not occupy space that might be filled with goods that pay a better freight.

Is the second mate required to go aloft when a heavy yard or mast is being sent up or down?

Yes; when the captain or mate is on deck, not otherwise.

Why not otherwise?

Because an officer should be on deck at all times to watch the trim of the sails, the manner in which the ship is being steered, and to "con" the helm, &c.

What dunnage should be laid for hemp, wool, flax or cotton?

At least seven inches in the flat of the floor, and nine to twelve in the bilges, with two inches up the sides.

How far should the "wing bales" of the second tier be kept from the sides?

Five inches at least.

If the ballast be damp sand or gravel, what precaution should be used?

The ballast should be covered with boards.

How should oil, wine, spirits, beer, molasses, tar, &c., be stowed?

Bung up, bilge free, chime to chime, and bilge and cantline, with good cross-bed at the quarters, and hanging, beds should never be trusted.

How should the tiers be secured?

Each tier should be well chocked off with billets of wood.

How many heights of pipes and butts may be stowed on each other?

Three heights of pipes, or butts, may be stowed on each other with safety, but not more.

How many heights of puncheons, hogsheads, or half puncheons, may be stowed on each other with safety?

Four, and not more.

How should all moist goods and liquids, such as salt, hides, bales of bacon, butter, lard, grease, castor-oil, &c., be stowed?

Apart from and under dry goods, if under, a double mat or boards should cover them.

How much dunnage should tea, flour (in barrels), flax seed, clover seed, linseed, or rice (in tierces), coffee, and cocoa (in bags), have?

At least seven inches in the bottom and at the upper parts of the bilges, and two inches all the way up.

How many tiers of tierces may be stowed on each other?

Six heights, but not more.

How many heights of barrels may be stowed on each other, without an intervening deck?

Not more than eight heights.

Is it the second mate's duty to see all these rules carried out?

Yes, but it should be the *captain's especial* duty to see his dunnage properly laid, and the ground tier properly stowed.

How should railroad iron, copper, ingots, bar iron, nail rods, copper ore, guano, &c., be stowed?

All these goods should be raised up as much as possible in the middle of the ship, tapering forward and aft.

Why should dead weight cargoes be stowed in the way you describe?

Because if these cargoes be stowed evenly over the ship's hold and low down, the ship will be liable to roll, or pitch her masts over the side in the first heavy sea.

In stowing brown and white sugar, what should be observed?

To keep them apart, or to stow the brown under the white, and both from contact with saltpetre.

How much dunnage is required for pot and pearl ashes, tobacco, bark, indigo, madder root, gum, &c.?

At least nine inches in the bottom, and two up the sides.

How many heights are allowed of barrels of provisions and tallow casks?

Five heights without an intermediate platform or deck can be stowed with safety, and no more.

How should bundles of iron rods, sheets of copper, iron, or other rough goods be stowed?

Apart from bales of fine goods, such as silk, or manufactured cotton or linen.

QUALIFICATIONS FOR CHIEF MATE.

In addition to the foregoing, a chief mate is required to understand observing azimuths and to find the variation of the compass thereby; to compare chronometers and find their errors and rates; to find the longitude by chronometer by means of altitudes of the sun, moon, stars, and planets; to find the latitude by the altitudes of the sun, moon, stars, or planets, on or off the meridian; to keep the ship's and official log-books correctly and truthfully; and he must be a man of strictly sober habits, and *should be* at least 22 years of age, and have been six years at sea, one, at least, of which, should have been spent in the capacity of second mate.

PROBLEM 24.

REDUCTION TO THE MERIDIAN.

Being at sea in latitude 53°. 23′ N. by account, when the sun's declination was 12°. 30′ South at 11h. 29m. 25s. by a watch that had been regulated at a place 50′ to the Eastward, the correct *central* altitude of the sun was 23°.41′ South. Required the true latitude at noon by reduction to the meridian.

	H. M. S.
Time per watch	11 29 25
Correction for longitude 50′ East, in time ...	— 0 3 20
Apparent time of observation	11 26 05

	H. M. S.
Apparent time of observation	11 26 05
Subtract from	12 00 00
Apparent time from noon	33 55

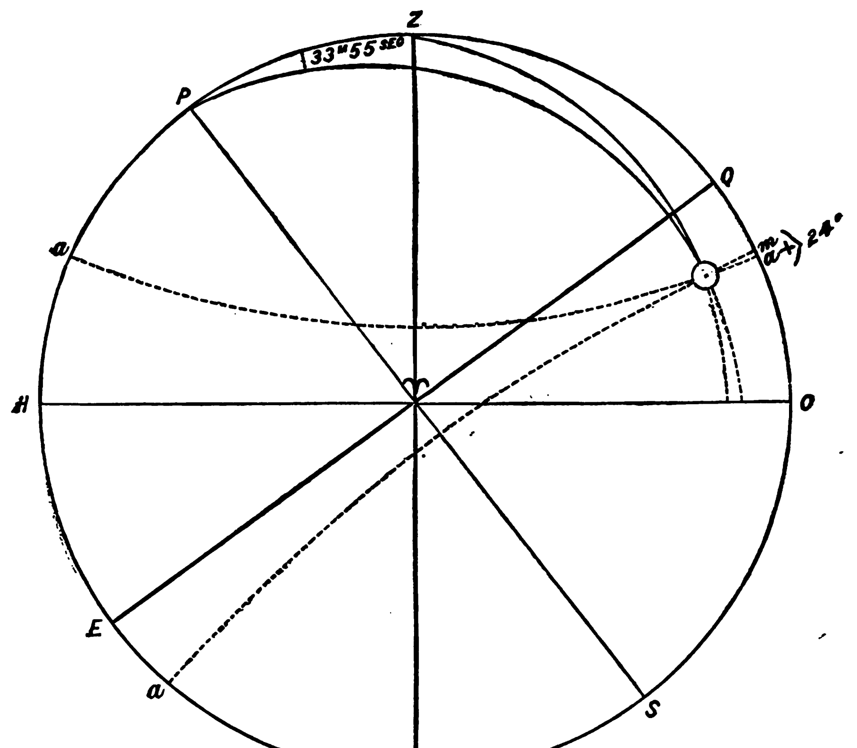
Latitude 53°. 28′		Log. co-sine	9.77558
Declination 12°. 30′ S.		Log. co-sine	9.98958
Apparent time from noon 33m. 55s.		Log. rising	3.03859
Natural number	636	Log.	2.80375

Sun's altitude 23°. 41′ Natural sine 40168

M. Z. dis. 65.55 N. Nat. co-sine 40804
Declination 12.30 S.

Latitude 53.25 North.

By construction.



With the chord of 60°. describe the primitive circle Z H N O to represent the meridian of the place of observation, in which Z represents the zenith, N the nadir, and H O the horizon. Draw the horizon, and at right angles thereto the prime vertical. Now with the secant

of the complement of the sun's true altitude describe the parallel *a a*, the sun's altitude above the horizon at the time of observation. With the tangent of the time from noon turned into degrees = 8°. 28'. 45"—describe the meridian on which the sun is at that time. Where this last drawn meridian intersects the parallel of altitude will be the sun's place. Now find the sun's declination at the time and place of observation. With the secant of its complement laid off from ♈ describe the parallel of declination through ☉, cutting the meridian in *a m*, the sun's place at noon (very nearly); now with the chord of the declination at noon, and one foot of the compass in *m*, find the place of the equator at Q, and it is done, for Q Z measures 53°. 25' North. The difference between *a* and *m* = 24' is the reduction, which being added to the correct altitude = 23°. 41' gives 24°. 5' for meridian altitude, 65°. 55' = Z D, and 53°. 25' for latitude.

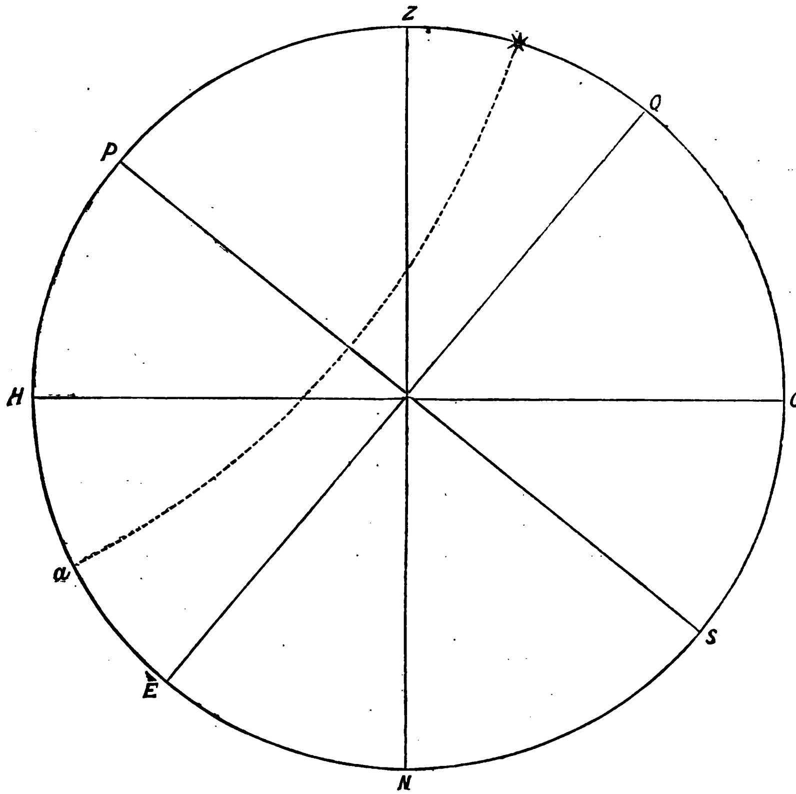
PROBLEM 25.

LATITUDE BY A PLANET'S MERIDIAN ALTITUDE.

On the 31st day of March, 1860, being at sea in longitude 41°. 47 W. the meridian altitude of the planet Jupiter was observed to be 73°. 45'. 30" S., the eye of the observer was elevated above the level of the sea 18 feet; required the true latitude.

	H. M. S.
Jupiter's meridian passage, March 31st	6 31 48
Longitude, 41°. 47' in time, West	+ 2 47 08
Time at Greenwich	9 18 56
Jupiter's declination, March 31st, noon	22°.56'.07" N.
As 24H.: 24S.:: 9H. 18M. 56S.: to correction ...	— 12
Jupiters' true declination	22 55 55N.
Observed altitude	73 45 30
Dip for 18 feet...	— 4 11
	73 41 19
Refraction for 74°.	— 16
Jupiter's correct attitude	73 41 03
Subtract from	90 00 00
Jupiter's zenith distance	16 18 57N.
Declination	22 55 55N.
True latitude	39 14 52N.

Construction.



With the chord of 60°. describe the primitive circle to represent the meridian. Draw the horizon H O, and the prime verticle, Z N. Now the planet's *correct* altitude is found to be 73°. 41′. 03″. above O the horizon; therefore with the chord of 73°. 41′. 03″., in the compasses, and one foot in O, extend toward the zenith on the meridian, and the other foot will place the planet at ∗. Now the planet's true declination being found = 22°. 55′. 55″ N., take its chord in the compasses, and with one foot in ∗, extend to the Southward (as the declination is North, but were it South extend to the North), and the place of the equator is found at Q; draw Q E through the centre, and at right angles thereto, the axes P S. With the co-secant of the declination describe the parallel of declination *a* ∗ and it is done, for Z Q, H P, O S, and E N express and measure the latitude = 39°. 14′. 52″ North.

PROBLEM 26.

TO FIND THE VARIATION OF THE COMPASS BY AZIMUTH.

On the 1st day of June, 1860, when the Sun's declination was 22°. 04'. North, the true altitude of his centre was observed to be 35°. 38'., and at the same moment his centre bore by azimuth compass E by S, or 101°. 15'. from N.; required the true azimuth, and the variation of the compass. The latitude of the place of observation being 39°. 25' North.

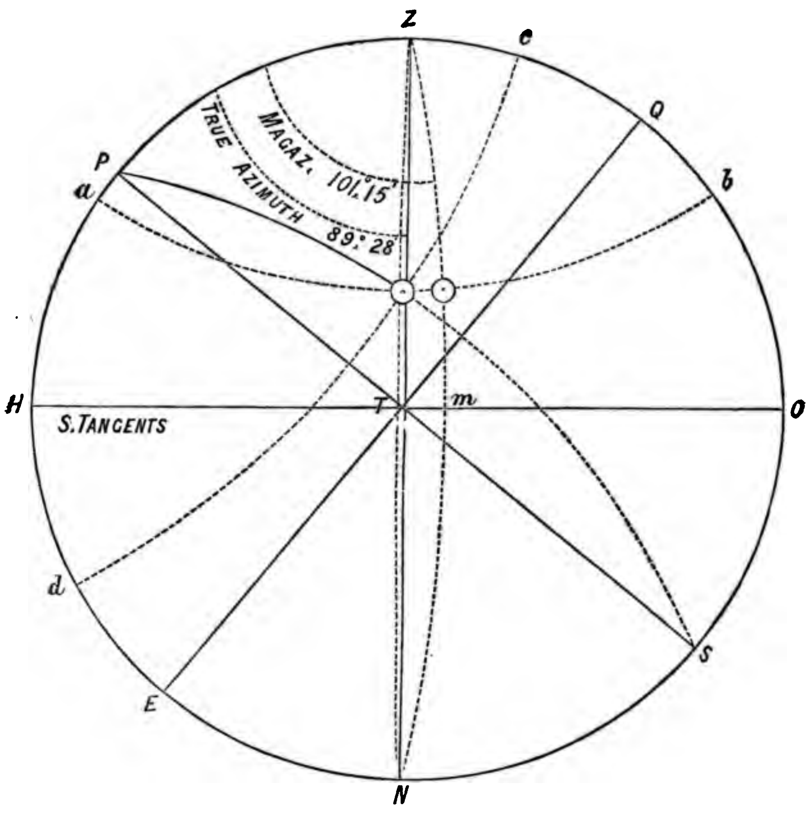
Sun's polar distance	...	67°.56'		
Latitude	...	39 . 25	Log. secant	0.11207
Central altitude ...	...	35 . 38	Log. secant	0.09004
		2)142 . 59		
½ sum	...	71 . 29	Co-sine	9.50185
Polar distance ...	...	67 . 56		
Remainder	...	3 . 33	Co-sine	9.99917
				2)19.70313
½ true azimuth ...	...	44°. 44'.	Co-sine	9.85156
		× 2		
True azimuth ...	...	89 . 28	from North	
Magnetic azimuth ...	...	101 . 15	„ North	
Variation	...	11 . 47	West, because the	

true azimuth falls to the *left* hand of the magnetic.

Construction.

With the chord of 60°. describe the primitive circle Z H N O, draw the horizon H O, and at right angles thereto, the prime vertical Z N. Lay off the latitude, = the elevation of pole from H to P. Draw the equator at right angles to the axis P S. With the secant of the complement of the altitude = 53°. 22', describe the parallel of altitude *a b*, = to 35°. 38' above the horizon H O. Draw the magnetic azimuth circle with the tangent of 101°. 15'; the intersection of this circle, Z ☉ *m* N, with *a b*, shows the sun's place by compass. Now with the co-secant of the declination describe the parallel *d c*. The intersection of this circle with the parallel of altitude *a b*, shows the sun's true azimuth *Z* ☉ T N,

= to 89°.28′, the difference T m = 11°.47′. is the error of the compas, and it is Westerly because the true azimuth lies to the left hand of the magnetic.



QUESTIONS ON THE ABOVE.

What is meant by the magnetic azimuth?

The magnetic azimuth is an arc of the horizon measuring the azimuth angle formed at the zenith by the meridian of the place of observation, and the verticle circle indicated by the *compass* bearing of the sun or other celestial object.

What is the true azimuth?

The true azimuth is also an arc of the horizon measuring the azimuth angle formed at the zenith by the meridian of the place of

observation and that vertical circle on which the sun or other celestial object *is*, as proved by calculation.

What is the polar distance of the sun, moon, star, or planet?

The polar distance of any celestial object is an arc of a meridian intercepted between the object and the *elevated* pole, and is the complement of its declination when the declination and latitude are of the same name, but when the declination and latitude are of contrary names, the polar distance is expressed by the declination added to 90°.

What is the true central altitude of the sun or moon?

The altitude of those objects which have a sensible diameter is generally taken by bringing the lower or upper limb to the horizon. This *observed* altitude of the respective limbs must be corrected for *semidiameter*, dip, refraction, and paralax, to obtain the true *central* altitude, which is an arc of a vertical circle intercepted between the centre of the object and the horizon.

What is the zenith distance of a heavenly body?

The zenith distance is an arc of a vertical circle intercepted between the centre of the object and the zenith, and is the complement of the true central altitude of that object.

Why do you add together the latitude, altitude, and polar distance to find the true azimuth?

Because these are three sides of an oblique-angled spherical triangle, given to find the angle at the zenith. In the foregoing example, had we used the complements of the latitude = 50°. 35′, and altitude = 54°. 22′, with the polar distance = 67°. 56′, the result would have been the same within 2′. Thus—

Co-latitude	...	50°.35′	Co-secant 0.11207
Co-altitude	...	54.22	Co-secant 0.09004
Polar distance	...	67.56	
	2)	172.53	
½ sum ...	...	86.26	Sine ... 9.99916
Polar distance	...	67.56	
Remainder	...	18.30	Sine ... 9.50148
			2) 19.50275
½ true azimuth	...	44°.45′	Co-sine 9.75137
	×	2	

True azimuth ... ... 89.30 from the North, which is the same as the former method, nearly. (See construction page 57.)

PROBLEM 27.

LATITUDE BY A STAR'S MERIDIAN ALTITUDE.

On the 31st day of March, 1860, being at sea in longitude 74°. 36', West, the meridian altitude of Tauri (Aldebaran) was observed to be 67°.00'.20" South, the height of the observer's eye above the level of the sea being 18 feet. Required the latitude.

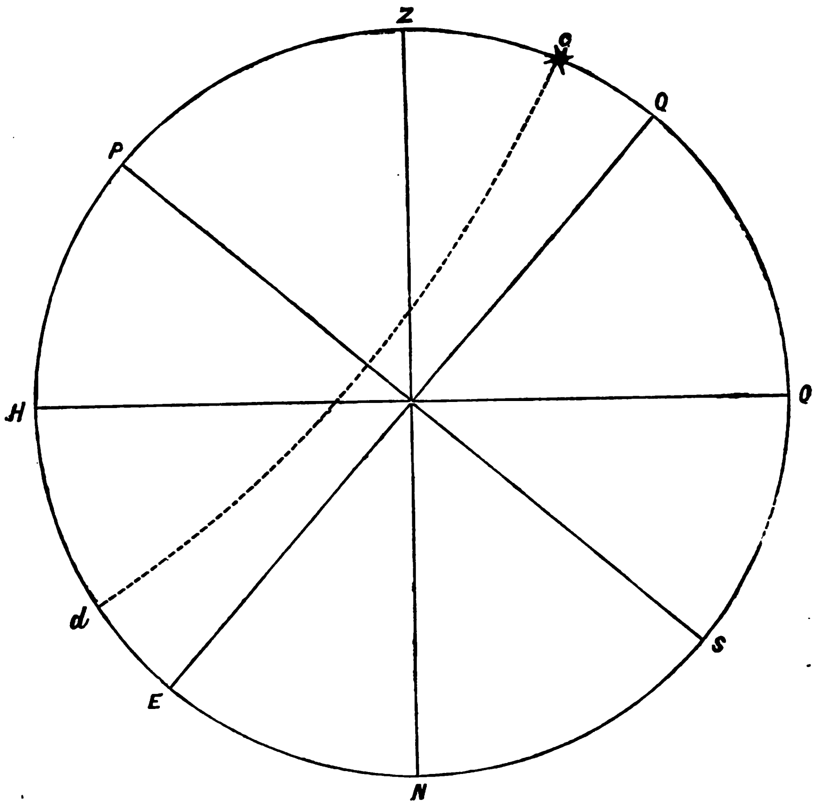
✱'s observed altitude	67°.00'.20" S.
Correction for dip 18 feet	— 4'.11"
	66°.56'.09"
Refraction for 67°	— 24"
✱'s true altitude	66°.55'.45"
Subtract from	90°.00'.00"
✱'s zenith distance...	23°.04'.15" N.
✱'s declination	16°.13'.34" N.
True latitude	39°.17'.49" North.

It will be perceived that the principle of finding the distance of the zenith of a place from the equator, (which is the latitude,) by any of the stars, is exactly the same as by the sun or moon, the only difference being the corrections for semidiameter in the latter objects, and the necessity to correct their declinations for longitude and time past or before noon at Greenwich. With the stars this is unnecessary, as their change of declination is too small to affect the latitude to any material extent.

Construction.

With the chord of 60° describe the primitive circle Z H N O to represent the meridian, in which Z is the zenith, N the nadir, H O the horizon. Draw the horizon H O and the prime vertical Z N. With the chord of the altitude = 66°. 55'. 45" in the compasses and one foot in O, find along the primitive the place of the star at ✱. Now with the chord of the declination = 16°. 13'. 34" extend from star ✱ Southward (because the declination is North), and the place of the equator is found at Q. Draw the equator E Q, and at right angles thereto the axis P S. With the co-secant of the declination describe the parallel

d c, and it is done, for Q Z, H P, E N, and S O express the true latitude = 89°. 17′. 49″.



PROBLEM 28.

LATITUDE BY THE MERIDIAN ALTITUDE OF THE MOON.

On the 28th day of Januray, 1860, the meridian altitude of the moon's lower limb was found to be 86°. 28′. 30″ South, the eye of the observer being elevated 18 feet above the horizon. The longitude of the ship was 15°. 45′ West. Required the true latitude of the ship.

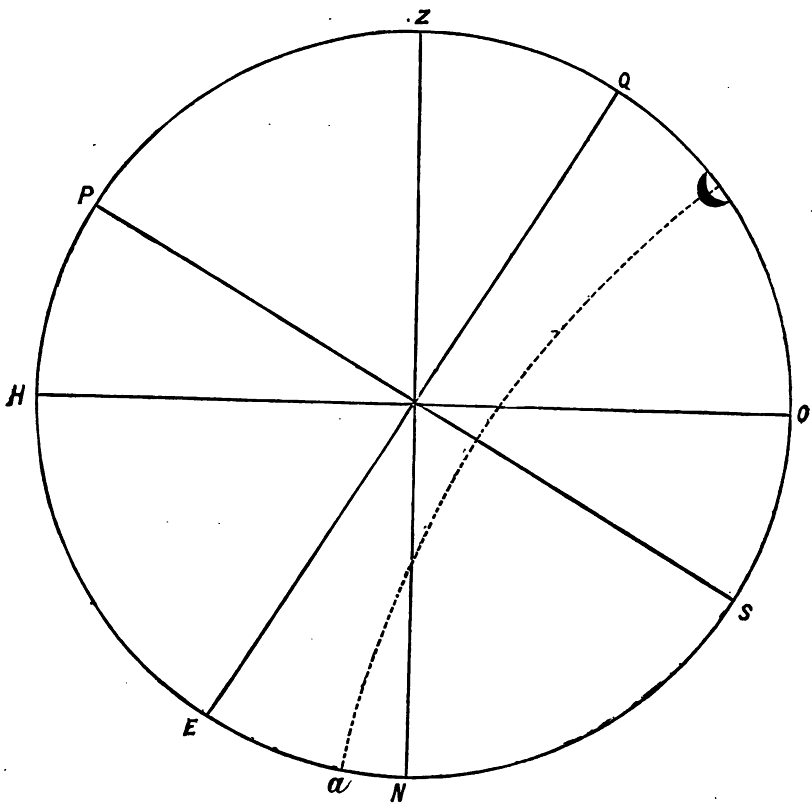
		H. M. S.
☽ 's meridian passage on January 28th, 1860		8 11 42
Longitude 15°. 45′ in time (West) ..	+	1 08 00
Time at Greenwich		9 14 42

☽ 's paralax for noon, January 28th		58′.20″
As 12h. : 12″.6 : : 9h. 14m. 42s. : correction	—	9.6
True horizontal paralax		58.10.4
☽ 's semidiameter at noon, January 28 ...		15′.56″
Correction for Greenwich time	—	2.5
☽ 's corrected semidiameter		15.53.5
☽ 's augmentation	+	9
☽ 's true semidiameter...		16′. 02″.5
☽ 's true declination at 9h. January 28th ...		21°.02′.37″
Correction for 14m. 42s.	+	2.18
☽ 's correct declination		21.04.55 S.
☽ 's observed altitude (lower limb) ...		36°. 29′. 30″ S.
☽ 's semidiameter (above)	+	16 .02. 5
		36. 45. 32. 5
Dip for 18 feet	—	4. 11. 0
☽ 's apparent (central) altitude ...		36. 41. 21
Correction for paralax 59′.42″ and apparent altitude 14 . 21 = ...	+	45.21
☽ 's true central altitude		37.26.42 S.
Subtract from		90.00.00
☽ 's Zenith distance		52.33.18 North.
☽ 's declination		21.04.55 South.
True latitude		31.28.23 North.

By Construction.

Draw the primitive circle with the chord of 60°. let the zenith be represented by Z, the horizon by H O; draw H O through the centre of the primitive circle. With the chord of the ☽ 's true altitude, lay off her place from H O, = to 37°. 26′. 42″, at ☽; find the moon's true declination = 21°. 04′. 55″ S., and with its chord find the place of the equator at Q; draw the equator Q E and the axis P S; describe also

the parallel a ☾ and it is done for Q Z and H P, express and measure the latitude on the line of chords = 81°. 28′. 23″ North.



PROBLEM 29.

LATITUDE BY A SINGLE ALTITUDE OF THE POLE STAR TAKEN AT ANY TIME.

The North Star is of all the celestial objects the most convenient for determining the latitude in the northern hemisphere, as it may be observed at any, or every hour, during a clear night, and a little practice will render this observation as simple and correct as any other.

The great improvement in nautical instruments, has in a great measure removed the difficulty which formerly existed in taking the altitude of this beautiful star. Most respectable ship-masters and

officers at the present day provide themselves with the sextant, the glasses of which are supposed to be much better than those of the ordinary quadrant, and although the star *Polaris* is between the second and third magnitude, it requires good glasses and some practice, with keen vision, to obtain absolute accuracy, owing to the diminution of brilliancy by the reflection and re-reflection from glass to glass, and then against the sky beyond the horizon. This is particularly the case in high Northern latitudes. Yet it is often very desirable to be certain of the latitude within 5′ or 6′, and it is astonishing to what perfection this observation may be made by a little practice. In order that the young navigator shall more clearly understand the principles of this beautiful problem, let us suppose a RIGHT SPHERE, in which the poles of the world are in the horizon. The Pole Star will *rise* and *set* to the observer on the equator, apparently revolving round the North celestial pole in its diurnal motion in its orbit. The star's greatest altitude in this diurnal revolution will be its polar distance. This can only occur when the star's right ascension and that of the meridian agree. The star will then be on the meridian. Six hours afterwards the star will *set* to the westward of the Pole, and at 1°.26′ distant from it. In another six hours it will have performed half its circuit, and have arrived at the meridian below the Pole. At the end of the third six hours the star will again appear to the East of the Pole in the horizon, and in six hours more it will be again on the meridian, due allowance being made for its daily acceleration. Now having the latitude, the star's declination, and its altitude, it is easy to calculate what altitude the star will have in any part of its orbit, as seen from the equator. This is simply the solution of a spherical triangle, in which we have the star's polar distance, the co-latitude as the two sides, and the star's distance from the meridian as the angle comprehended between them, to find the star's true altitude, which, subtracted from 90°., leaves the star's correction of altitude, or the difference between the true alitude of the star and that of the Pole. The elevation, or altitude of the Pole is always equal to the latitude. In the construction of this Problem (on page 64) the star's correction is given for all the HOURS of right ascension; for any fraction of an hour a proportion can easily be taken, all the corrections above the *double horizontal line* being subtractive, and those below that line additive to the star's true altitude to obtain the latitude.

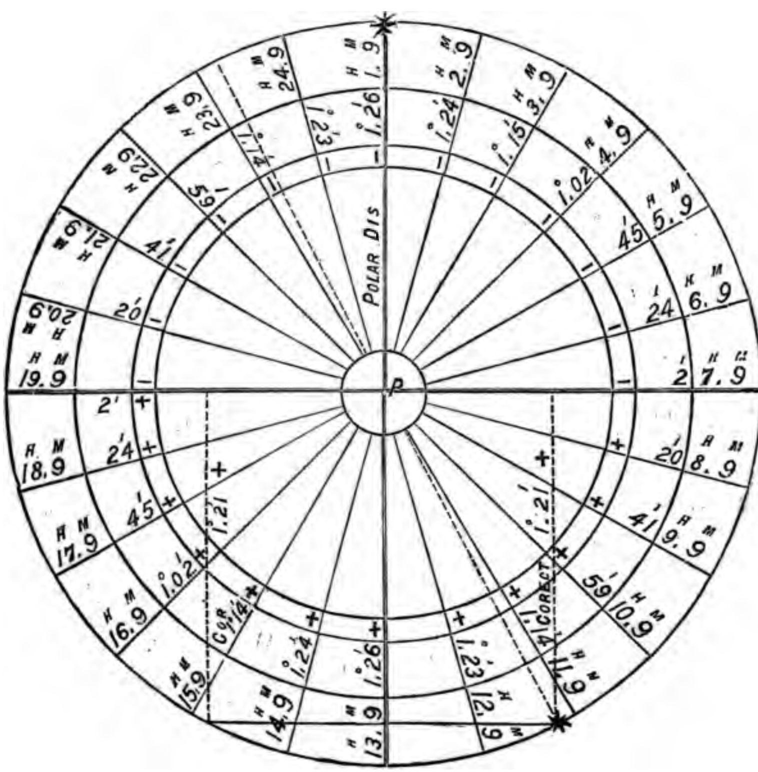
Example.

On the 10th day of May, 1860, being at sea in longitude 60° W., the observed altitude of the pole star was 52°. 15′. 5″., when the watch

showed 8h. 6m. 28s., the height of the eye of the observer being 16 feet above the level of the sea. Required the latitude.

	H. M. S.
Hour of observation at ship	8 6 28
Sun's corrected right ascension	3 12 09
Right ascension of the meridian	11 18 32
Observed altitude of the star	52°.15'.05"
Correct for dip 16 feet, 3'.56"—Refraction 45" =	— 4'.41"
Star's true altitude	52°.10'.24"
Correction corresponding	+ 1°.21'.00"
True latitude at time and place	53°.31'.24"North.

Construction.



QUESTIONS ON THIS PROBLEM.

What is meant by the right ascension of the meridian?

The right ascension of the meridian is an angle formed at the pole by the equinoctial colure, which passes through the first point of aries, and that celestial meridian, passing through the zenith of the observer and centre of the star; or it is the distance of the meridian on which the star is, from the meridian passing from the pole through the equinoctial at the first point of aries, and is always equal to the hour of the day and the sun's right ascension.

Why is there a correction corresponding to the right ascension of the meridian necessary?

Because the north star is *not on the pole,* but moves (or appears to move) round the celestial pole at a distance of 1°.26′; so that when the star is on a meridian, one hour and nine minutes removed from the XXIV hour meridian,* or equinoctial colure, it is 1°.26′ above the pole, hence its correct altitude exceeds the elevation of the pole by that quantity, and 1°.26′ must be subtracted from the corrected altitude of the star, to find the elevation of the pole, which always expresses the latitude. Again, when the star has reached 7h. 9m. of right ascension, it is equal in altitude with the pole, and then this correction disappears; this will also be the case at 19h. 9m. But when the star's place is on the meridian representing 13h. 9m., the 1°.26′ becomes additive; as he is then, his whole polar distance *below* the level of the pole, and his correct altitude is consequently too small by that quantity. It is evident from what has been said, that from 1h. 9m., to 7h. 9m., an interval of six hours—every minute must make a difference in the subtractive corrections, as the star changes his position. The same may be said of the six hours from 19h. 9m., to 1h. 9m., these corrections being also subtractive; and the 12h. from 7h. 9m. to 19h. 9m., are subject to the same constant change, and are all additive quantities. (See construction, page 64.)

PROBLEM 30.

LATITUDE BY DOUBLE ALTITUDES OF THE SUN.

On the 23rd day of July, 1860, when the sun's declination was 20°

* The right ascension of Polaris is = 1h. 9m. 25.6s. and his annual variation in right ascension *additive* is 19s.

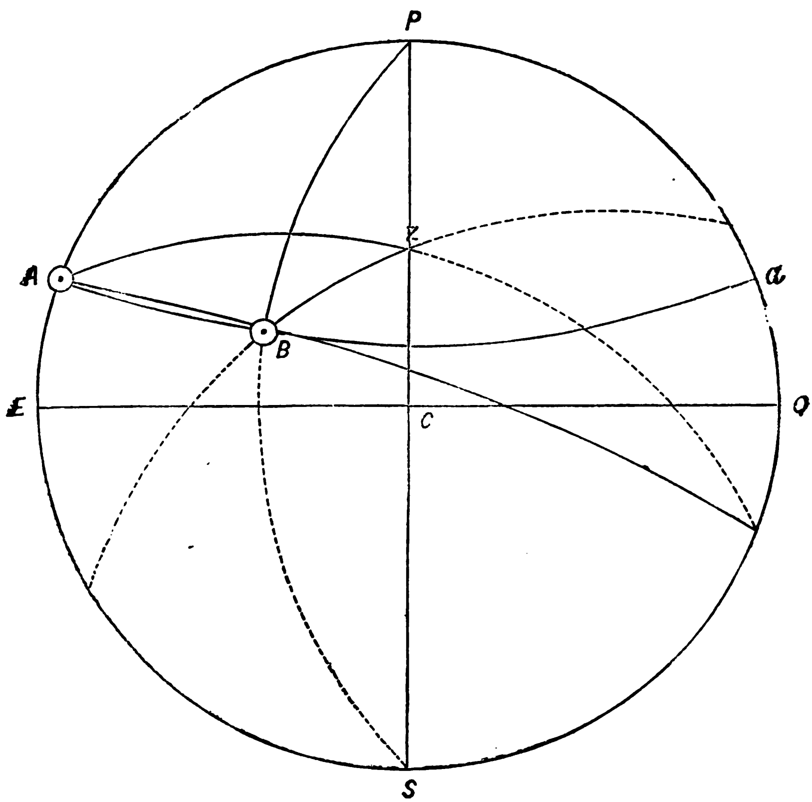
North in the forenoon, his true altitude was found to be 18°.30′, and three hours after, his true altitude was 44°. Required the latitude.

Hour angle 3h.	Co-sec. 10.41716			
Declin., 20° N.	Secant 10.02701	... .		Co-sec. 10.46595
Angle A ..	Co-sec. 10.44417	Co-sine 9.96991		Co-sine 9.96991
½ sum alt. 31°.15′	Co-sine 9.93192	Co-sec. 10.28502	∠ B 21°.30′ N.	Co-sec. 10.43586
½ diff. alt. 12 . 45	Sine 9.34380	Secant 10.01084		
Angle C ..	Sine 9.71989	Co-sine 9.93007	.. .. ..	9.93007
		Secant 10.19584	= ∠ Z 50 . 26 N.	
			∠ E 71 . 56	Sine 9.97804
			Latitude 54° .02′.00″ N. ..	Sine 9.90811

Note.—The angle B is named N. or S., *like the declination.* E is the sum of Z and B when of the same name, but the difference when of contrary names. Z is N. or S. like the bearing of the zenith, from the sun.

Construction.

Let the primitive circle represent that hour circle on which the sun was at the first observation, E Q being the equator, then A *a*, the parallel of 20° declination gives A the sun's place at first sight, and as C Q is the tangent of 45°, Q will be the centre of the hour circle P B S, three hours distant from the former; its intersection B, with the parallel of declination is the sun's place at the second observation. About ⊙ A as a pole, at the distance of 71°. 30′, the first zenith distance, describe an arc of a small circle. About ⊙ B as a pole, at the distance of 46°. 00′ the second zenith distance, describe another small circle, cutting the former in Z the zenith; through Z A, Z B, A B, P Z, describe great circles; and it is done for Z P is the co-latitude, and measures 35°. 58′, hence the latitude is 54°. 02′ N.: the sun's bearing by compass should be taken at the time of the *first* observation, and the ship's course and distance during the elapsed time should be noted, and if the difference between the sun's bearing and the course steered be *less* than eight points, the difference of latitude made during the elapsed time, must be added to the first altitude, to obtain the true altitude to be used in the work, but subtract the difference of latitude



made from the first altitude if the number of points be more than eight, and that altitude will be reduced to what it would have been, if it had been observed in the same place where the second observation was made. This corrected altitude is to be used with the second *observed* altitude, and the latitude will be that of the place of the second altitude.

Example.

In a ship's running N. by E. ¾ E. per compass, at the rate of nine knots per hour, at 10 h. 00 m. A.M. per watch, the sun's correct central altitude was found to be 13°. 18′, bearing S. ¾ E. by compass, and at 1 h. 40 m. P.M., per the same watch, the true central altitude was

found to be 14°. 15′. The latitude by account being 49°. 17′ N., and the sun's declination being 23°.28′ South. Required the latitude.

TO FIND THE FIRST ALTITUDE.

The elapsed time between the observations was 3 h. 40 m., and in that time the ship sailed 33 miles upon the course N. by E. ¾ E., which is 13¼ points from the sun's bearing at the first observation, = S ¾ E. The complement of which to 16 points in 2¾ points. Now by inspection or logarithms, we find that 33 miles of distance on a course of 2¾ points wide, gives 29 miles difference of latitude, which must be *subtracted* from the *first* altitude, 13°. 18′ because the ship sailed more than eight points from the sun, therefore this first altitude will be 12°. 49′, which must be used in the rest of the work.

First altitude	12 .49′
Second altitude	14°.15′
Sum of altitudes	27°.04′
½ sum of altitudes	13°.32′
Difference of altitudes	2) 1°.26′
½ difference of altitudes	0°.43′

Hour angle 3h. 40m.	Co-sec.	10.33559					
Declin., 23°.28′ S.	Secant	10.03749			.. ..	Co-sec.	10.39988
Angle A ..	Co-sec.	10.37308	Co-sine	9.95704		Co-sine	9.95704
½ sum alt. 13 . 32	Co-sine	9.98777	Co-sec.	10.63076	∠B 26°.05′ S.	Co-sec.	10.35692
½ diff. alt. 0 . 43	Sine	8.09718	Secant	10.00003			
Angle C ..	Sine	8.45803	Co-sine	9.99982		Co-sine	9.99982
			Secant	10.58765	∠Z 75 . 01 N.		
					∠E 48 . 56	Sine	9.87734
			Latitude 48°.54′ N.			Sine	9.87716

In these calculations the formula should be drawn or *cut* on the slate before the operation is commenced, which will facilitate the work very much, as there is but one table used. If the change in the decli-

nation during the elapsed time were taken into account, the result would differ to the extent of two or three miles; especially when the hour angle or elapsed time is great; but a proper allowance for the ship's run will in general give a sufficiently correct result for practical purposes.

PROBLEM 31.

TO FIND THE SUN'S TRUE DECLINATION AT ANY PLACE.

Required the sun's true declination on the 21st day of July, 1864, in longitude 45°.59'.30" West of Greenwich, at 3h. 14m. 50s. P.M.

	H. M. S.	
Time at ship, July 21st	3 14 50	diff. dec.
Longitude 45°.59'.30" East (in time) —	3 3 58	29". 4 = 1h.
Time past noon at Greenwich	0 10 52	4.90 = 10m.
		24 = 30s.
Sun's declination at noon at Greenwich,		16 = 20s.
July 21st, 1864	20.23.41	2 = 2s.
Difference of declination for 1h. = 29".4,		
proportion for 10m. 52s.	— 5. 3	5".3 = 10.52
Sun's correct declination	20.23.35.7	N.

CORRECT THE FOLLOWING COURSES FOR ERRORS, AND FIND THE TRUE COURSES.

Compass course.	Deviation.	Variation.	Wind.	Lee way.	True courses.
S.S.E. ¾ E.	¼ pt. W.	pts. 1¼ E.	S.W.	1¼ pts.	S.E. by S.
N.E. ¾ E.	5°. E.	22°.30' W.	N.N.W.	2¾ „	N. 66°.52' E.
S.W. by S. ½ S.	3°.30' W.	18°.00' E.	S.E.	1¼ „	S. 59°.29' W.
N.N.W. ¾ W.	7°.25' E.	26°.20' W.	West	2¼ „	N. 24°.32' W.
W. by S. ¾ S.	3°.12' W.	16°. E.	N.W.		S. 83°.07' W.
W.N.W. ¼ W.	2°.10' E.	28°.30' W.	North	1¾ „	S. 63°.40' W.
S.S.W. ¼ W.	7°. W.	21°.10' E.	S.E.		S. 39°.29' W.
N.N.E.	6°. E.	17°.16' W.	East	1¾ „	N. 8°.27' W.
North.	2°.49' W.	21°. W.	E.N.E.	1 „	N. 35°.04' W.
N. by E. ¼ E.	2°.48' W.	22°. E.	East	2¼ „	N. 7°.57' E.

PROBLEM 32.

LONGITUDE BY CHRONOMETER.

On the 15th day of August, 1864, being at sea in latitude 41°.36′ North, in the afternoon, the observed altitude of the sun's lower limb was 39°.57′, and at the same time a chronometer (which was, on the 15th of January, 1864, *fast* of Greenwich mean time 7m. 35s.5, and *losing* daily 3s.7) showed 7h. 23m. 40s. The height of the eye of the observer was elevated above the level of the sea 21 feet, and the sextant had an error of 1′.22″ additive. Required the true mean time of observation at the ship, and the longitude by that chronometer, also the variation of the compass; the magnetic bearing of the sun's centre at the time of observation was 93°. from the North.

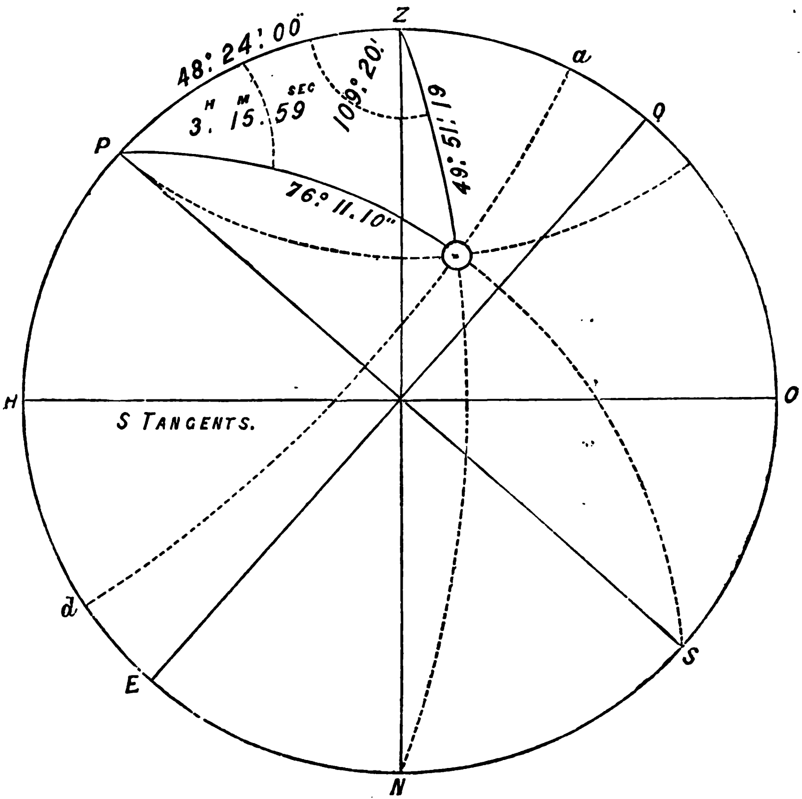
		H. M. S.
Time shown by chronometer		7 23 40
Original error on 15th day of January, 1864, fast	—	7 35.5
Time by chronometer corrected for original error		7 16 04.5
Accumulated rate in 213 days × by 3s.7 = losing	+	13 08.1
True time of observation at Greenwich... ...		7 29 12.6
Sun's observed altitude (lower limb)		39°.57′.00″
Correction for dip, 21 feet	—	4 31
		39 52 29
Correction for error of sextant	+	1 22
		39 53 51
Correction for refraction, 40°	—	1 08
		39 52 43
Correction for paralax	+	8
		39 52 51
Sun's semidiameter	+	15 50
Sun's correct central altitude		40 08 41

Sun's declination 15th August, at noon, at Greenwich	13°.54′.42″N.
Difference of sun's declination in 1h. = 47″ . 1 × 7h. 29m. 12s.6 = correction for Greenwich time —	5 . 53
Sun's correct declination	13 . 48 . 49 N.
Subtract from	90 . 00 . 00
Sun's polar distance	76 . 11 . 11

Sun's true altitude	40°.08′. 41″	... ...	Secant 0.11670
Ship's latitude ...	41 . 36 . 00	Secant 0.12622	Secant 0.12622
Polar distance ..	76 . 11 . 11	Co-sec. 0.01275	
Sum ...	2) 157 . 55 . 52		
½ sum	78 . 57 . 56	Co-sine 9.28190	Co-sine 9.28190
Remainder ...	38 . 49 . 15	Sine 9.79719	
Second remainder	2.46.45	... ...	Co-sine 9.99949
		2) 19.21806	
Apparent time by observation ...	H. M. S. 3 11 52	Sine 9.60903	
			2) 19.52431
½ true azimuth		54°. 40′	Co-sine 9.76215
Equa. T. at noon 4m.11s.4, correct = +	4 07	× 2	
Mean time of observation ...	H. M. S. 3 15 59	109°.20′	T. Az. from N.
		93°.	Magnetic azimuth
Mean time by chronometer ...	7 29 12.6	16°.20′	Difference = variation 16°.20′ West
Longitude in time =	4 13 13.6		
True longitude ...	63°. 18′. 24″ West.		

Construction.

Let the primitive circle represent the meridian, H O the horizon, Z N the prime vertical; make H P the height of the pole = to the



latitude 41°.36′; draw the axis P S and the equator E Q; lay off the declination *d a* = 18°.48′.49″ North, the altitude 40°.08′.41″, and describe the parallels of declination and altitude; the intersection of these parallels shows the place of the sun in ⊙. Through Z ⊙ N describe the azimuth circle Z ⊙ N, and through P ⊙ S describe an hour circle P ⊙ S. Then the angle ⊙ Z P will be the azimuth angle = 109°.20′, and the angle ⊙ P Z being measured will give the true time required = 3h. 15m. 59s.

Using the three sides of the oblique angled spherical triangle formed by the complements of the altitude and latitude, with the polar distance, the result would be the same, in both the time and the azimuth; thus—

Co-altitude or zenith distance...	49°.51′.19″		
Co-latitude or distance of zenith from pole	48.24.00	Co-secant	0.12622
Polar distance of the sun ...	76.11.11	Co-secant	0.01275
Sum	2)174.26.30		
½ sum	87.13.15	Sine	9.99949
Remainder	37.21.56	Sine	9.78313
			2)19.92159
	H. M. S.		
Apparent hour angle	3 11 52	Co-sine	9.96079

Again:

Co-altitude or zenith distance...	49.51.19	Co-secant	0.11670
Co-latitude as above	48.24.00	Co-secant	0.12622
Polar distance	76.11.09		
	2)174.26.28		
½ sum	87.13.14	Sine	9.99949
Remainder	11.02. 5	Sine	9.28190
			2)19.52431
½ azimuth	54°.40′	Co-sine	9.76215
	2		
True azimuth	109.20	from the North	
Magnetic azimuth	93.00	from the North	

Variation ... ... 16.20 West, because the magnetic azimuth falls to the right of the true.

PROBLEM 33.

LONGITUDE BY A PLANET'S ALTITUDE AND A CHRONOMETER.

On the 4th day of September, 1864, the true altitude of the planet Jupiter was found to be 26°. 36′. West of the meridian. The latitude of the place of observation was 43°.30′ S.; at the same time the chrono-

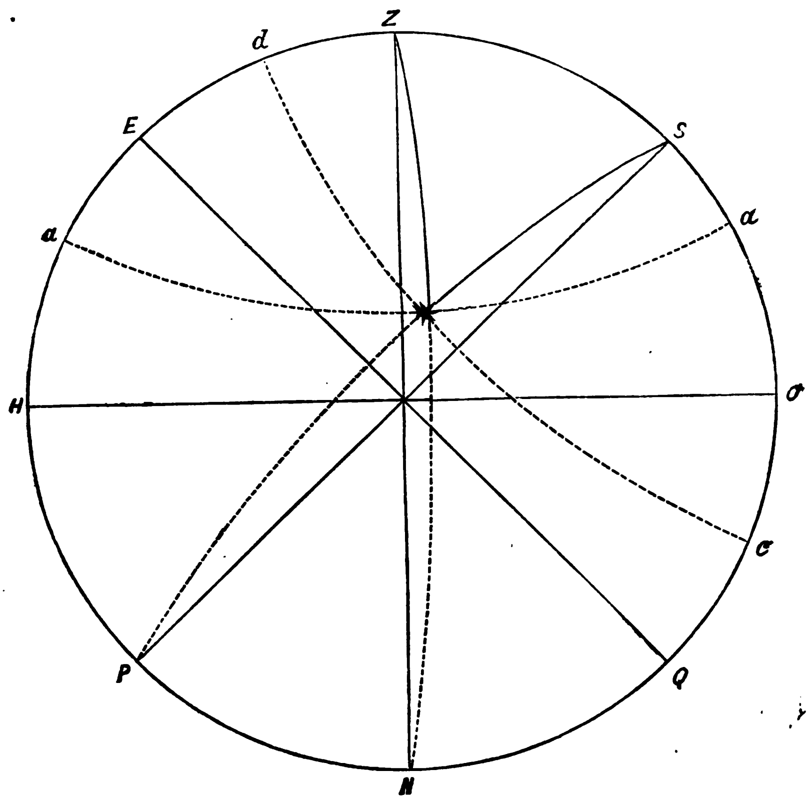
meter regulated to mean time at Greenwich, showed 12h. 54m. 32s. Required the apparent and mean time at ship and the longitude by that chronometer.

Preparation.

			H. M. S.
Time at Greenwich by chronometer			12.54.32
Jupiter's declination at noon, Sept. 4th			22°.51'.38.7" S.
Correction for 12h. 54m. 32s. and 34s., change in 24h.			+ 18.7
Jupiter's true declination			22.51.57.4 S.
Subtract from			90.00.00.0
Jupiter's South polar distance			67.08.02.
			H. M. S.
Jupiter's right ascension at noon, 4th Sept. ...			17.15.27.54
Correction for 12h. 54m. 32s., and 15s.73 change in 24h.			+ 8.12
Jupiter's true right ascension			17.15.35.66
			H. M. S.
Sun's right ascension at noon, 4th Sept.			10.53.18.88
Correction for 12h. 54m. 32s. and 9s. 3. change in 1h.			+ 2.00.06
Sun's correct right ascension			10.55.19.
			M. S.
Equation of time at noon, 4th Sept.			1.09.27
Correction for 12h. 54m. 32s. and 0.821 change in 1h.			+ 10.60
True equation of time subtractive, f.a.T.			— 1.20.00
Jupiter's true altitude	26°.36'		
Latitude	43 . 30	Secant	10.13944
Jupiter's polar distance	67 . 08	Co-secant	10.03555
Divide by	2)137 . 14		
½ sum	68 . 37	Co-sine	9.56182
Remainder	42 . 01	Sine	9.82565
			2)19.56246
	H. M. S.		
Jupiter's distance West of meridian	4 57 25	Sine	9.78123
Jupiter's right ascension... ...	17 15 36		

		H. M. S.
R. A. meridian		22 13 01
Subtract ☉'s R. A.		10 55 15
App. time at ship's		11 17 46
Equation of time	—	1 20
Mean time at ship's		11 16 26
Mean time by chronometer ...		12 54 32
Longitude in time		1 38 06 = 24°.31'.30" West.

By Construction.



This construction is in every particular the same as the last, viz., the co-altitude = ✱ Z = 63°.24'; the co-latitude, S Z = 46°.30'

and the polar distance S ✱ = 67°. 08′. 03″. To find the angle ✱ S Z = 4h. 57m. 25s., giving 11h. 16m. 26s. mean time, as shown by the sun.

PROBLEM 34.

TIME AND LONGITUDE BY CHRONOMETER AND A STAR'S ALTITUDE.

On the 18th day of September, 1864, when a chronometer that had been set to Greenwich mean time on the 1st day of May, but was gaining 6.25s. daily, showed 10h. 24m. 40s.; the observed altitude of the bright star in Canis Minoris (Procyon), was 28°. 26′. East of the meridian. The height of the eye was 18 feet above the level of the sea. The latitude of the ship being 10°. 30′ S. Required the mean time and longitude by chronometer.

		H. M. S.
Time shown by the chronometer	...	10 24 40
Accumulated rate, 140 days × 6.25 fast =	...—	14 35
Greenwich mean time by chronometer ...	...	10 10 05
Sun's right ascension, September 18th ...	...	11 43 40.82
Correction for Greenwich time, 10h. 10m. 05s.	...+	1 30
Sun's correct right ascension	...	11 45 10
Equation of time, September 18th ...	...	5m. 59s. 16
Correction for Greenwich time	...+	8 . 79
Correct equation of time subtractive from ap. T.	...	6m. 07 . 95
Procyon's right ascension, September 18th	...	7h. 32.17
Procyon's declination, September 18th ...	...	5°.33′.58″ N.
		90 . 00 . 00
Procyon's South polar distance	...	95°.33′.58″

Procyon's observed altitude	...	28°.26′.00
Dip 4′.11″, refraction 1′.45″ = —		5 . 56
Procyon's true altitude	...	28 . 20 . 0 4

Procyon's true altitude ...	28 . 20 . 04		
Latitude	10 . 30 . 00	Secant	10.00733
Polar distance	95 . 33 . 58	Co-secant	10.00205
Sum	2) 134 . 24 . 02		
½ Sum	67 . 12 . 01	Co-sine	9.58829
Remainder	38 . 51 . 57	Sine ...	9.79762
			2) 19.39529
	H. M. S.		
Procyon's distance from meridian	3 59 12	Sine ...	9.69764
Procyon's right ascension ...	7 32 17		
Right ascension meridian ...	3 33 05		
Subtract sun's right ascension ...	11 45 10	H. M. S.	
Apparent time at ship	15 47 55	15 41 47	Mean time at ship.
Equation of time ... ... —	6 08		
Mean time by chronometer...		10 10 05	
Longitude in time		5 31 42=82.55.30 E.	

ADJUSTMENT OF THE SEXTANT.

1st. To find the Index Error.

Having screwed on the inverting telescope, and adjusted the eye-tube to distinct vision, screw on the coloured eye-piece; then hold the sextant vertically, and measure the diameter of the sun by moving the index *on* the arch (that is, to the left of 0°. on the arch); also measure the diameter of the sun by moving the index *off* the arch (that is, to the right of 0°. on the arch). Half the difference of these diameters will be the index error: *additive,* if the diameter, as measured *on* the arch, is the *greater; subtractive* if it is the *less.*

To ascertain whether the observation has been made correctly, add the two diameters together, and divide by 4, which should give the semi-diameter of the sun as found in the Nautical Almanac, p. 3, corresponding to the given date.

If the altitude is below 20°., the sextant should be held horizontally, and the horizontal diameter measured, both *on* and *off* the arch, as before.

2nd. To set the Axis of the Telescope parallel to the plane of the Sextant.

Screw on the telescope, and turn the tube containing the eye-glass until two of the wires are parallel to the plane of the instrument Then take the distance between two objects not less than 90°. distant, as the error is more easily ascertained at a large angle than at a small one. In taking the distance, the objects should be brought in contact at the wire nearest the instrument; and then, by moving the plane of the sextant a little, until the objects appear at the other wire, observe whether the contact remains. If the objects remain in contact, the telescope is parallel to the plane of the instrument; but, if they separate, the object-end of the telescope inclines towards the plane of the instrument; if they overlap, the object-end of the telescope is inclined from the plane of the instrument. In the latter two cases, the telescope must be adjusted by means of the proper screws.

THE LOG-BOOK.

A log-book is an official, and should be a true and correct, register of all the transactions which happen on board of a ship, whether at sea or in harbour: such as coming to anchor, getting under weigh, loosing, setting, taking in or unbending sails, reefing, furling, &c., mooring or unmooring, the number of men employed on board, whether belonging to the ship's company, or hired labourers; what supplies have been received on board, the amount of cargo received and delivered daily; the state of the wind and weather, together with every minute circumstance connected with, or relating to any mishap or accident that may occur during the voyage, either to the ship, her tackle, apparel or furniture, or the cargo thereof, whether on board, in boats, or on shore. This book should be a true and faithful transcript of the log-board or log-slate, on which every occurrence should be correctly and truthfully entered at the time of its happening, or at the end of each watch, when at sea, by the officer of the deck, or by whoever had charge during the occurrence.

The ship's time should be kept by astronomical account, namely, the date beginning at the moment of noon, and counting onward to twenty-four hours. Thus, what landsmen call the 10th, at 9h. A.M., is in reality the 9th at 21h.

When a ship is bound to a distant port or place, the bearing and distance of that port or place should be computed by Mercator's rules. If islands, capes, or headlands intervene, the courses and distances to

these must be severally calculated, and the variations of the compass for each day should also be observed, and applied to the true course found.

All these calculations should be entered in the proper place, and at length in the log-book. At the time of leaving the land, the bearing of some point or place is usually carefully observed, whose latitude and longitude are known, which, together with the estimated distance of the ship from such point or place, is to be noted on the log-board. This is called taking a *departure.* As the distance inferred from estimation is very susceptible of error, particularly in hazy weather, or when that distance is considerable, it is advisable to make use of the following method of taking a *departure,* viz., let the bearing of a well-known place be observed, and when the ship has run a convenient distance on a direct course let the bearing of the same well known place be again observed; then there will be a triangle formed in which there is a side given, i. e., the distance sailed between the observations, and all the angles, to find the true distance between the ship and the place observed; in like manner may the departure be taken from a lighthouse at night. The results of all these observations are to be entered in the log-book. In making out the first day's work, care must be taken to enter, as a course and distance sailed, the point opposite to the bearing of the land or lighthouse from which the departure was taken, and that due allowance be made thereon for the variation of the compass. Thus, if the compass had two points of westerly variation, and the light or land from which the departure was taken bore N.E. by E., then the true course for the "traverse table" would be S. W. by S. The course steered as indicated by the compass, and the distance sailed by the log, each hour are entered on the log-board with chalk, together with what sail is set or taken in, whether the ship makes or ships water, and if the pumps have been attended to; the lee-way or drift, if any, that the ship is making, all these should be carefully noted on the log-board. It is generally the duty of the chief officer to make this official record of the transactions and occurrences which happen on board in the log-book. But it matters not who "keeps" or writes the "log," so that it be a faithful and true record of facts. The log-book is the property of the "parties concerned," viz., the owners and underwriters. The statements made in a ship's log-book are the only legal evidence of the cause or causes of any damage that may be sustained by the ship or cargo on board, and from those statements protests are made. Protests are mere copies of the facts contained in the log-book. Therefore, as no protest is considered legal without the

signature of at least three of the crew, besides the captain, all of whom are required *to swear, in the most solemn manner, to the truth of every statement*, it should be the duty of him who keeps the record to avoid, by all means, any false or coloured representation of any transactions that may take place on board. Should a chief officer be disrated during a voyage, the second officer may be appointed in his stead to keep the "log," or the captain himself may write it, taking care to have the signatures of his second officer, carpenter, and one or more of his crew to certify to the truth of any extraordinary statement that it may be necessary to make; this should also be the case when the chief officer keeps the log under the same circumstances. The statements should be read over to those who are required to certify to their truth, as soon after the occurrence to which they refer as is found convenient, and while the whole matter is fresh in the memory of all on board. In case of illness of any officer or other member of the ship's company, the fact, the nature of the disease, and the medicine administered in such case, should be entered in the log-book. In case of the death of any officer or seaman, an inventory of the effects of the deceased should be immediately and truthfully taken, and copied into the log-book, together with the amount of wages due to him at the time of his death. Should the crew become mutinous or insubordinate, all the circumstances that led to such mutiny or insubordination should be carefully, impartially, and minutely recorded, as that record is often necessary to prove the facts before a court, and therefore the necessity of a neat, clean, well kept log-book will be clearly apparant. It is disgraceful to an officer, and reflects no small discredit on claims, when the log-book is slovenly kept; viz., badly written, badly spelt, ungrammatically and ambiguously indited. Why should a ship's log-book, the contents of which (as evidence, &c.), are of such vast importance to all parties concerned, not be kept as clean and well written as the books of a merchant on shore? How much more pleasantly are claims settled, when all the facts connected with loss or damage are clearly set forth in a business-like style? And, lastly, in case of fire or wreck, every exertion should be made to secure and preserve the log-book; next to human life, the log-book should be saved and preserved, in order that the circumstances connected with the disaster, and the exertions to save the wrecked ship and cargo; together with the names of all who neglect or refuse to exert themselves in the same, may appear and serve as evidence in the case of litigation, either with such persons or the underwriters. The loss of the log-book bespeaks great carlessness, and often reflects discredit

on the captain and officers, and begets suspicion in the minds of all parties concerned; and will in some cases very much prolong the settlement of claims. For the statements of individuals, as to transactions which happen prior to, and during the disaster, are apt to be contradictory, may lead to a law suit, and much delay in procuring that evidence which the log-book would, if properly kept, at once supply.

SPECIAL DUTIES OF CHIEF MATE.

What are the special duties of chief officer?

The duties of Chief Mate are numerous and arduous, both in port and at sea.

What are his duties in port?

To look after the safety of the ship, to superintend and give directions what duties are to be done. And in everything, to have the views, wishes, and commands of the Captain carried out to the fullest extent. It is the mate's duty to superintend the rigging of the masts, and everything connected with the sails, yards, spars, booms, anchors, pumps, boats, provisions, and cargo of a ship.

What has he to do with the staying of the masts?

To see that the lower masts are raked properly, and that they do not touch the partners at the upper deck, that they are upright, or form the proper angles with the ship's beam; that the upper masts stand in line with the lower masts, and that they are all properly secured.

What are the mate's duties relative to the pumps?

To see that they are put, and *kept* in perfect good order for working, that the breaks, boxes, bolts, leather, and tacks are good, and that a sufficient supply be provided before sailing. That the well be sounded frequently while loading, and the ship's water-line marked at each foot, or less, that the ship goes down in the water.

Why should the well be thus frequently sounded?

So that the position of a leak may be known, should the ship suddenly begin to make water.

What are chief mate's duties in regard to the boats?

To see that they are all properly secured and kept in good order, and at all times ready for use.

What are the chief mate's duties as regards the cargo?

It is the duty of the chief officer to receive and give receipts for all cargo, to measure every package, and to enter these measurements with the marks and numbers, and the names of the shippers in the cargo-book, and to fill up the column of "solid contents" in the same book.

What should a mate observe in giving receipts for goods?

That the marks and numbers agree with those set forth in the "shipping note," that all the packages are unbroken, and otherwise in good order, and if there be any appearance of damage or imperfection, that fact should be mentioned in the receipt given for the goods by the mate.

What is it necessary to observe in receiving casks of liquids?

That they are *full to the bung;* that the hoops and staves are sound, and that the casks are *sufficiently strong*, and not leaky.

Is it proper for a mate to give a receipt for goods before they are actually shipped?

No; but it is done in some ports, viz.: Liverpool, London, and American ports. Goods are received on the wharf or quay alongside, but this custom leads to many vexatious mistakes.

What is the mate's duty with respect to taking in cargo?

The mate should see that slings of sufficient strength be used, and that *slings*, and *not can-hooks*, be used in hoisting liquids.

When heavy cargo is to be taken in by a yard tackle, what should the mate see to particularly?

If the yard be not untrussed and lashed to the mast, the mate should see that the yard is well secured by a stout topping-lift or derrick, and a powerful rolling-tackle.

What is the mate's duty with regard to time?

The mate gives the time to work, to eat, to sleep, and to do all the duties of the vessel, both in port and at sea.

What is his duty as regards the ship's stores?

The mate's duty requires him to take and keep a just account, both of the ship's and cabin stores by weight, measure, or numbers, entering the same in the "Store Receipt" Book.

What is the mate's duty as regards water stores?

The mate should examine all tanks and casks, to see that they are in perfect order and clean; that they are *all filled*, and that a quarter of a pound of unslacked lime and a pound of charcoal be put into each iron tank before closing it for the voyage, and half that quantity into each 120 gallon cask; and that one cask or tank be *all used* before another is broached.

What is the chief mate's duty as regards the crew?

To see that they are all properly berthed, and that they have their meals at the appointed moment, and that all their provisions are well, cleanly, and properly cooked; that they have as much time to rest, sleep, or otherwise amuse themselves, as the ship's duty will allow;

that the "forecastle" is regularly cleaned once a week, and that the men keep themselves clean and decent.

What are the mate's duties with respect to "working ship?"

The chief officer works, or attends to the working of the fore part of the ship when the captain or pilot has charge, or is on deck working the ship; but when at sea, and the captain is not on deck, the chief mate has full command: his place is then on the quarter-deck.

What are the mate's duties as regards the log-book?

It is the mate's duty to keep the official, and ship's log, entering therein, in due form, and with strict regard to truth, every transaction, such as getting under way, coming to, making or taking in sail, taking observations, with their results, the course and distance sailed each hour, the ship's position as often as it is ascertained, what water the ship is making, how often the pumps are attended to, the direction of the winds, state of the weather, height of the barometer and thermometer, and every minute circumstance connected with any damage that may happen to the ship or boats belonging thereto; time of leaving or making the land, its bearing and distance; when the pilot left, or came on board, whether the leads are, or are not kept going; the number of hands sick and what remedies are administered, what extra hands are employed and for how long; should a steamer, boat, or stevedores be employed, a ship spoken or signalled at sea, all should be entered in the log-book.

Who does the log-book belong to?

To the underwriters and owners.

Why is the log-book thus strictly kept?

Because it is the only official evidence of any accident, and from the statements therein made protests and other legal documents are drawn up in legal form.

What is the mate's duties as to protests?

It is the duty of the mate to keep a truthful log as the foundation of the protest, which he is required by his duty to swear to. When a protest is drawn up the log-book must be sent to the notary public, who puts the contents of the log-book in legal form, and the chief mate is by his duty required to sign and swear to the truth of such protest.

Has the second mate anything to do with this protest?

Yes; he is required to sign and swear to the truth of it.

How is the second mate to know whether these statements are true?

Because he is supposed to be on board and to know them, though

he is not, in the capacity of second mate, required to keep the log; and law and usage requires three or more signatures to the protest.

Should the chief mate be guilty of a misdemeanour, is he bound to enter that in the log?

He is, in honour, bound to state the *truth in every* case.

What is the mate's duty towards passengers?

Simply to be accommodating and respectful, as becomes a gentleman, observing and requiring strict propriety and discipline, as becomes an officer.

What is the mate's duty towards the captain?

To be respectful and obedient to all lawful commands, and to have them carried out promptly and strictly, whatever they may be.

Has the chief mate power to disrate or displace any subordinate officer?

No; that power rests entirely with the captain.

When the captain is out of the ship, has the mate power to do as he pleases in ship's duty?

Yes; he is for the time captain, and is only responsible to the captain for his acts.

If the captain be expected on board, what should the mate do?

It is usual for the chief mate to keep the deck till the captain arrives, and to meet him at the gangway.

Is the chief mate supposed to stay on deck at night until the captain arrives?

No *good* mate will go to bed if the captain is expected; but no good captain will keep his chief officer up late at night, when it can be avoided.

Should the mate go to bed before the captain arrives, what should he do?

Have a good look-out set, with orders to call him when the captain's boat is heard, or when he comes on board.

What relations should exist between the captain and his chief officer?

The utmost harmony, consistent with strict discipline, should, on all occasions exist, otherwise good order cannot be maintained.

What are the chief mate's principal duties at sea?

His principal duty is to keep the sails in the best possible trim, to keep all possible sail on the ship, and to attend to the ship's course, to see that the compasses are right, and that all the ship's rigging is well and properly preserved from destruction, and that the pumps are regularly sounded and kept in order.

Is the chief mate supposed to be a navigator?

Yes; a chief officer should be as good a navigator as the captain, because if any accident should happen to the latter, or should he be sick or die, the chief mate will have charge of the ship.

What branches of navigation should the chief mate understand in order that the ship may be safe in his hands ?

He should understand the use of the quadrant and sextant, how to find his latitude and longitude by meridian altitudes, and by chronometers, to find the time of high water, and the course and distance from his ship to any place, to find the variation of the compass by amplitude and by azimuth, to find the ship's position and distance from the land by cross bearings, to correct the sun and moon's declination and right ascension for longitude, to correct courses for variation, deviation, and lee way, to find the right ascension of the meridian, so as to ascertain the latitude by the North Star or by the moon's altitude. He should also understand the rules of the road.

What other qualifications should a chief mate possess besides the above ?

A chief officer of a ship should be a man of strictly sober habits and of gentlemanly bearing; but there are *many* other branches of nautical science which he *should* understand, but which more particularly and immediately belong to the captain's position.

THE MASTER.

There is no member of society from whom more is expected and demanded than the ship's master. His office is one of great power, dignity, and responsibility. Not only is the whole property of the vessel, her cargo, and her earnings within his power, and their safety dependent upon his honesty, his prudence, and energy, but the very lives of the crew and passengers hang, as it were, on the master's experience and watchfulness. Apart, therefore, from the nautical qualifications which he ought to possess in the highest degree, there are various other circumstances connected with his profession which call for the exercise of high qualities of character.

The ship-master, anxious for distinction in his profession, should bear in mind that he holds a position of great responsibility, and is invested with an authority and discretion which are not paralleled by any other relation in private life. That, in addition to his having the entire command of the ship, he is by law, in cases of necessity, or of unexpected and pressing calamity, created an agent for the benefit of all concerned, and that, generally, his acts, under the exercise of a

sound discretion, bind all parties interested in the voyage, whether owners, shippers, or underwriters.

When visiting foreign countries, feeling justly proud of the noble specimen of art over which he has command, he should also bear in mind that ship-masters are, generally, regarded as our principal representatives, and the standard by which the people of those countries judge us; and that if they are found to have clear, well-defined, and accurate ideas touching the requirements of commercial law, and to be ready and competent, in all cases of disaster, to exercise their own judgment, without the dictation of consignees, agents, or surveyors, who are not always disinterested, it will added create confidence in his ability; and sobriety and integrity will conduce largely to our national honor and reputation.

It is not, however, to be presumed that masters, in the midst of their various duties, can be familiar with all the rules of law governing the multitudinous cases growing out of marine disaster. Nor can they, in all cases, even be presumed to know how particular acts or a particular course of proceeding will affect the different, and sometimes conflicting interests of the shipowner, the freighter, and of the several underwriters upon ship, freight, and cargo. There are a few general principles of law and usage, which may aid him in determining what he ought to do for the advancement of the general interest on putting into an intermediate port in distress.

The broad equitable principle, touching these several interests, is, that he should act upon the responsibility of his own judgment and without partiality. The best general rule for him to observe, is, to act as he believes a prudent man would act who was owner of both vessel and cargo, without insurance on either.

An intelligent ship-master keeps himself informed of all the circumstances relative to the disasters which lead to the losses and disbursements named averages. He enters, or causes to be entered a faithful and minute record in the ship's log-book, from watch to watch, of all that transpires. On arriving in port, he notes his protest, and extends it afterwards, by the aid of the log-book, and while all the circumstances of the voyage are fresh in his memory; taking care that it is a correct and clear statement of the events of the voyage.

In every disaster, the master should be careful to communicate it, by the readiest mode of conveying intelligence, with all details, both of the mode of the disaster and of the extent of damage or injury, to owners, consignees, or insurers, as they may be most near or easy to be sent to. Duplicates should be sent in case opportunities allow.

Neither the owner or insurer can act without them, and delay from want of communicating intelligence is often ruinous.

If the master find that he requires advice or assistance from others, merchants in the various considerable ports have been recommended by underwriters, to whose advice it will be most useful to him to resort. They are not only of well known respectability, but they, being in the high estimation of merchants and commercial men at home, will greatly aid in the settlement of claims arising out of disaster. Their advice and recommendation will, in general be the best voucher for the upright and honorable ship-master's intentions, as well as the wisdom of his measures.

An active master will seek for good and economical mechanics in repairing his ship; he will superintend the work himself, and will take care that credit for old materials and discount for prompt payment are duly deducted from the bills. He will also try and find the least expensive means of raising funds to meet the disbursements. Before he leaves the port he will take care to have all bills paid, and entered in a general account; and that account is sometimes certified by the consul or underwriters' agent.

In every case of disaster, the vessel must be repaired, if practicable, without a gross expenditure exceeding three-fourths of the value of the vessel, (that is, one-half after deducting one-third for new,) as valued in her insurance, or estimated at the place of beginning her voyage.

There is an impression current among nautical men, that, if a vessel cannot be repaired at such a cost as will not exceed half her value when repaired, she may be abandoned and sold. This is a false impression; the policies in England require that the cost of repairs under adjustment, as of a partial loss, shall exceed half the sum insured, or there can be no abandonment. The sum insured means the valuation of the vessel in the policy, and the cost of repairs means, the cost of materials and labor, *exclusive* of the expenses of delay, port charges, etc.

If full repairs cannot be made at all, or without extraordinary expense, temporary repairs must be put on the vessel, in order to complete the voyage; at its end these repairs will generally be fully allowed, and the full repairs may be made after getting into a suitable port for repairing, at the expense of the underwriters, as in other cases.

If spars are sprung, or sails or rigging injured, and cannot be readily replaced, or without great expense, every expedient with which a prac-

tised sailor is ever ready ought to be resorted to, in order to make the injured articles serve until arrival at some more convenient port where the repairs can be done completely. The repairs may then be made with advantage to all parties, without delay of the voyage, or an extravagant extent of expenditure, which is always more or less to the discredit of the ship-master.

When goods are found to be damaged in an intermediate port, the master should take care that they are carefully examined by competent persons, who will recommend proper steps to be taken for drying them, etc. If there is a danger of their perishing, or of injuring the other parts of the cargo by their re-shipment, a sale should be made of such portions, so as to avoid this inconvenience. And where there is an agent of the underwriters resident, the master may call him in to assist and advise; he may also be invited to attend the survey and sale, certify to the correctness of the papers, and see generally that due care is used in all parts of the transaction. An important object with the underwriters, in desiring to have their agent present, is to prevent that wholesale condemnation of goods which too frequently occurs.

If the damage is discovered at the *end* of the voyage, at the port of destination, it may also be desirable to procure the co-operation of the underwriters' agent. The master, with his assistance, should appoint competent merchants as surveyors, and he should see that a proper investigation is made, that a correct certificate of sound value is given, and that the papers are in all respects complete. A very material and useful document in the adjustment of loss is the actual account sales of the sound portion of the goods. It is preferable to a certificate of sound value.

In case the vessel shall be subject to salvage, it is proper always to have the vessel and cargo appraised at their value as brought in; and then the alternative be adopted either to bond the cargo and vessel, or to sell, as may be deemed necessary. The vessel, cargo, and freight may always be pledged by bottomry, to relieve the vessel and her cargo from salvage charges; and this is generally expedient. But if this cannot be done, and the vessel and cargo are not perishing so rapidly as to allow of no communication with the home of the vessel, a postponement of the sale ought always to be applied for, until advice or relief can be had from the owners or underwriters.

The master's authority to settle or to refer to arbitrators a claim for salvage upon his vessel or cargo; depends, like every other exercise of his powers as agent, upon the circumstances which

make such settlement or reference necessary and proper. In a country distant from his owners, where he cannot consult them without injurious delay, on a barbarous coast; or in countries where justice cannot be obtained in the courts, his powers must be considered as equal to the emergency, and his settlement made in good faith will be held valid. So also, in his own country, when the demand is small, it may often be to the interest of the owners that the amount should be settled at once by the captain, and the vessel proceed on her voyage, without waiting even a day for the purpose of consulting them. But in every case of settlement of salvage by the master, his conduct will be carefully watched and scrutinized by the courts, and his contracts will not be regarded as binding upon the parties concerned, unless they appear to have been *bona fide*, and such as a discreet owner, placed in like circumstances, would probably have made. If the case arises in our own or in a foreign country where tribunals having jurisdiction of questions of salvage are easily accessible, and where decisions are promptly made, and if injustice is done, appeals may be taken against the master's authority to play the judge himself, or to submit the case to arbitrators, must be considered as very much restricted. Of all the modes of settling a demand for salvage, an arbitration is usually the most injudicious for the master to adopt. He is very liable to be imposed upon, however cautious he may be, as he can scarcely ever know anything of the qualifications of the arbitrators. Besides, however intelligent or honest they may be, there is usually a spirit prevalent, in neighbourhoods where shipwrecks often occur, which the French call an *esprit de localite*, which warps the judgment of the most candid and upright men engaged in business, and renders their awards partial and unjust.

It is always to be borne in mind, that nothing but absolute necessity, or a cost to repair over three-fourths her value, can warrant a sale of the vessel; and not only will a sale otherwise made relieve the insurers, but the purchaser's title can be impeached whenever the vessel can be found in the Queen's dominions.

Such is the nature of the contract between the shipper and shipowner, and such is the law applicable to such contract, that *the master must not abandon the ship or cargo* upon any ground, when it is practicable for human exertions, skill, and prudence to save them, or any of them from impending peril. A loss of the goods caused by negligence, carelessness, and unskilfulness, or any loss which might have been prevented by human exertions, is not a loss by a peril of the sea, which exonerates the master and shipowner under their bill of lading.

from liability. After shipwreck, the master is bound to exert himself to the utmost to save the goods and to attend to their safe custody and preservation. In a recent trial it was held that the shipowner was liable for loss and damage happening to the cargo after the ship had stranded, because the master did not sufficiently exert himself to prevent such loss or damage.

When vessels are stranded on the American coast it frequently occurs that the master abandons the property to the wreck commissioner, under the impression that he is bound to do so. In this he is mistaken. In all cases the master should keep the control of the property, employing the wreck commissioner, if necessary, for advice and information, and as one through whom he can procure all needful assistance; and it is his duty to furnish it, when required by a master in distress. It is the master's duty to communicate at once, and as expeditiously as possible with the owners or underwriters.

It not unfrequently happens that vessels are sold by masters abroad, simply because funds cannot be readily obtained to pay for repairs, and it has become a system in many places, of late years, to advertise a loan on bottomry, and in case no offer is made within a few days, to sell the vessel. There is no justification for the sale of the vessel in the mere fact that money cannot be had on bottomry to pay for the repairs she needs. If it happens, in any case, that a master is unable to get money, and he chooses, for that cause, to abandon his vessel, he may do so without selling her. The right to sell is founded upon a totally different principle. If the vessel is in good safety, and may remain so until her owners, or their underwriters, can be informed of the want of money to pay for repairs, the master has no legal authority to sell her, and any title he attempts to give will be invalid. It is only when the vessel is so situated that there is imminent danger of her being totally lost, while waiting for advice from her owners, that the master is justified in selling her.

A contract of insurance is emphatically and purely a contract of indemnity; and the interests of commerce and of the public, require that its true character as such should never be forgotten, and in all doubtful cases be strictly maintained. Hence, the breaking up of a voyage ought never to be sanctioned when it is certain that the shipowner, if uninsured, would have continued to prosecute it; nor consequently the abandonment of a vessel as unnavigable, ever be sustained, when it is certain that the owner, if uninsured, would have elected to repair.

Arrangements relative to funds are, of course, more easy to make

when the owners reside in the same country in which the average occurs, and where there are means of communication between the master and his owners. Even in foreign countries it frequently happens that the ship owner has sufficient credit for the agent, or merchant disbursing average expenses on his vessel, to be satisfied with a "Bill of Exchange" upon him, without further security. It is exceedingly advantageous thus to be able to raise funds, and it saves considerable expense. But when money cannot be raised in this manner, the master should take an early opportunity of ascertaining the fact, communicating full particulars, with estimates of the probable expense, to his owners; and if his vessel is in a European port, he will probably be able to transmit intelligence and receive a reply by the time the vessel is again ready to prosecute the voyage. Where, however, the port to which the vessel may be driven for repairs will not admit of the master's consulting with the owners or underwriters, it is very usual, as we have said before, to pay the disbursements by a bottomry bond, but as this is an expensive means of raising money, the master should reduce the amount to be borrowed as much as possible; to do this he should apply the sale of any of the condemned stores of the ship, and the proceeds of any damaged goods, part of the cargo, which surveyors have recommended to be sold on the spot, in diminution of the amount of disbursements. Sometimes it is impossible to raise money at all on bottomry; and sometimes the rate demanded is so high as to appear ruinous, and other means of raising funds are resorted to. The master, under such circumstances, may proceed to sell a portion of the cargo; but he has no right to sell an entire cargo at an intermediate port, to raise funds to repair his vessel. He has the same right to sacrifice a part, that the remainder of the interests may reach their destination, that he has to throw a portion into the sea to procure the safety of the rest. A sale of part of the cargo should not be resorted to, except in the most urgent cases, and where the cargo will bring reasonable prices; for what is sold must be accounted for at the prices it would have brought on its arrival at the port of destination, which frequently will be with a heavy profit, and be ruinous to the voyage. This matter of selling should be carefully examined when proposed; no more than is aboslutely necessary should be disposed of; and the latest prices at the place of destination of the cargo to be offered for sale, should be first ascertained, before such a decision is taken, and a selection made of such cargo as is likely to occasion the least loss. The loss on such a sale will form an item in the average adjustment, and will be applied to the column of disburse-

ments *pro rata.* The loss is discoverable by the adjuster, by making a *pro forma* or simulated account-sales, as if the goods sold had arrived in a sound state, from which the account-sales will be deducted.

Should it be necessary to jettison a part of the cargo, care should be taken to throw overboard the least valuable and most weighty parts of it, if time and other circumstances will admit of the selection being made.

In case the voyage should be inevitably broken up by disaster or misfortunes, the master must carefully procure the proper protests, and accounts of what is saved, and of all his expenditures on that account. He should cause any balance of money, whether he supposes the vessel and cargo to have been insured or not, to be remitted in the surest way to his owners, or the consignors or consignees of the vessel or cargo. Such remittance will not affect the insurance, and will reimburse the owners of the property, some part of their loss the soonest.

The documents necessary to support a claim against the underwriters are the protest, the surveys, the general account of disbursements, the vouchers or receipted bills embraced by the general account, the rate of exchange, the bottomry bond, the value of ship, cargo and freight, a memorandum of the actual wages of master and crew, the ship's policy, and any other papers or letters which may throw light on the transaction, or give any information about it.

The maxim that "freight is the mother of wages," does not apply to the master, and he is entitled to recover of the owners his wages due at the time of the loss of the ship. He may also claim of those whose interests he represents, wages, or a reasonable compensation in lieu of wages, for the time and labor expended by him in closing up the business of the wreck; including therein his board, his passage money with the proceeds, and other necessary incidental charges, to be allowed in the final average statement.

It is the duty of the master's consignee to assist him in repairing his ship, and in preserving the property. He ought to furnish the master with honest and true accounts, and if he furnishes him with fictitious or overcharged bills, with a view to enable him to make money out of his owners on a settlement with them, or to enable the owners to make money out of the underwriters, he will forfeit his right to recover of the owners the money truly advanced by him; and a bottomry bond, taken by him under such circumstances, is void.

The master, being the agent of others, can make no money for his own use out of any business growing out of the disaster, either in the

shape of returned commissions, or overcharged bills, or in any other way; and he may be required to account, under oath, for all such gains.

Marine insurance, as it will be seen in a subsequent part of this work, is a contract of indemnity against those perils to which ships are exposed in the course of their voyage from one place to another. It gives greater security to the fortunes of private persons by dividing amongst them that loss, which would ruin an individual. This security tends greatly to the advancement of trade and navigation, because the risk of transporting and importing being diminished, merchants will more easily be induced to engage in extensive trade, to assist in important undertakings, and to join in hazardous enterprises. But it is not individuals only who derive advantage from the increase of commerce, the general welfare of the public is promoted. And notwithstanding the system of insurance is so advantageous to the spread and safety of commerce, it happens to be peculiarly open to fraudulent attempts. These attempts at fraud are made in various ways. They sometimes consist in getting the underwriters to pay for repairs, not arising from perils insured against; sometimes in making them pay for old defects or decay, discovered when the vessel was opened to effect repairs of recent damage; and sometimes in making them pay for improvements. When the metal sheathing has been on the ship so long that it needs renewing, an owner has sometimes been known to prevail on the surveyor to state, that to repair the damages it is requisite to strip the ship and re-metal her. If the surveyors are not men of integrity, they can greatly assist a dishonest owner or master in defrauding the underwriters. Hence the motive for underwriters desiring their agent to be present on the holding of surveys, and their suspicion of the correctness of the master's proceedings, when he has refused or neglected to consult the agent. Other frauds consist in goods, not unfrequently, being sent on board or alongside, in bad order, and in a damaged state. Should this fact escape detection, the dishonest merchant will have no difficulty in recovering the amount of damage from the underwriters. When the master does discover that the goods are damaged, letters of indemnity are sometimes offered by the shippers for signing the bills of lading "in good order." This is nothing less than conniving at fraud, and injuring the character of the master and the ship in the estimation of the underwriters. Every honorable ship-master should therefore reject with scorn, proposals of this nature. Other frauds consist in false accounts, false quantities and prices; bills simulated together, such materials never having being

employed about the ship; false or colored protests; and the concealment of discounts or allowances. A most improper proceeding is not unfrequently taken in intermediate and home ports, viz., that of making presents to the master, to induce him to agree to pass exhorbitant charges. And proposals are sometimes made by the consignee or agent, to divide the customary commission, provided the master will agree to have his cargo discharged, stored and re-shipped, in cases where there is no necessity of doing so. In some ports this commission is very exhorbitant, varying from 1½ to 5 per cent. In no case ought the cargo to be unladen, without the clearest necessity; it is not only very expensive, but always creates a great delay, and is apt to end in serious injury to the cargo. When unloading is absolutely necessary, the qualified ship-master will be careful to stipulate against the enormous charges of commission named above, as no substantial responsibility is thereby incurred, and in most cases the charge of commission for all such transactions is considered unreasonable. The master can always ascertion before he proceeds to discharge his cargo, what this commission will be, and if an unreasonable sum be required he can obviate the difficulty by keeping the entire control of the cargo in his own hands, and hiring store-room himself. A proper charge for storage and a regular commission for the general business of the ships under repair, will in most cases afford a fair and adequate remuneration. It is always proper to have suitable men employed to watch and take care of the cargo, whose compensation will fall into an average, general, or partial, and without any deduction; so also, any reasonable compensation to the merchant for his actual trouble, responsibility and services, will be justly chargeable and freely allowed. The difference between such charges and a commission will be obvious to any intelligent ship-master. Another species of fraud is, that salvors often present the captain with part of their gains, that he, on his part, may not resist their claims, and may be induced to give a false account of the accident and its consequences.

A ship-master who connives at any of these frauds, places himself in that pitiable condition in which a man finds himself, when he has lost his honor. We are satisfied that every honorable and true seaman, will reject with scorn any insulting proposal of this nature. When any of these fraudulent practices are discovered, it not only blasts the master's reputation, but probably ruins his professional and pecuniary prospects for life. If his character become known to the underwriters throughout the country, they will of course refuse to write on a ship or cargo under the charge of a man of doubtful integrity. These prac-

tices, too, when discovered, excite in the underwriters, and others, who it is intended shall be defrauded by them, a just and natural indignation, which frequently results in creating a suspicion in cases where no ground for suspicion exists; and thus, by the unscrupulous selfishness of one man, an injury may be done to a number of innocent persons.

The mode of insurance often adopted, making merchants mutually insure each other, seems to work well. They are thus all interested in the safety and preservation of their property, and they are beginning to see that a master who understands his BUSINESS, is the only man to place in charge of ships—to be a *sailor* is just no qualification for a MASTER,—every man before the mast, should be, and probably is, as good a sailor as he, yet no man will contend that every man before the mast is fit to command. The present mode of COACHING through a stereotyped examination, is the very WORST way of obtaining competency on the quarter deck; for we assert without fear of contradiction, that that man who coaches, and rides through the examination of the Board of Trade to the quarter deck, having no other knowledge than is required to pass, is not fit in any particular to hold the responsible position of MASTER.

SPECIAL DUTIES OF THE MASTER.

What are the special duties of a master of a ship at sea?

The duties of a master are both numerous and arduous. First, he is the responsible party in all things relating to the ship, her cargo, and the lives of all on board; he is accountable for the passage, navigating the ship, giving the courses that are to be steered from day to day, and the manœuvres of the vessel are performed under his command and superintendence; and all on board are subservient to his orders, and are bound by the article to be obedient to him in everything relative to the ship and her movements.

What are the captain's duties as regards the crew?

The captain's duty is to engage or ship the crew and officers, and to enter into an agreement with them as to the voyage, and when the voyage is to terminate; and also any rules of dicipline which he may intend to establish on board, the time at which the duties of the officers and crew are to commence, etc.

What are the captain's duties as regards his ship in port?

To have her put and kept in first-rate order, properly sparred, rigged, stowed and watched; and when she is to be moved, to be on board to

superintend the movement. No captain should be out of his ship when she is to be moved or shifted.

What are the captain's duties relative to the cargo?

To see the ground tier laid, and to give directions how he wishes the dead weight distributed in the hold; and to sign the bills of lading when the mate's receipts are presented.

What are the other duties of the captain when in port?

The captain, as agent for the owners of the vessel, makes all the necessary arrangements for supplies of every kind, or for having all necessary work done on board; purchases provisions, rope, sails, anchors, boats, or any other tackle or apparel that the ship may require. He also engages with passengers, receives passage money, and does everything as the owner would do it, if himself were present.

What are the qualifications necessary to constitute a commander of a ship?

The commander of a ship should be a man of the most undoubted courage, the strictest integrity, of pure and scrupulous honour, a first-rate sailor, and a gentleman in every sense of the word.

What other qualifications should a captain possess?

He should be a first-rate navigator, of sound nautical judgment, of a pure moral character, forbearing, yet strict in discipline, and should understand the nature and use of all the medicines in his medicine-chest, and the use of the lancet.

What other knowledge should he possess?

He should understand all the laws that govern British shipping, and those relative to the conveyance of goods and passengers; those regulating pilots, together with all the rights and privileges of seamen and officers; the laws of marine insurance, relative to averages, abandonment, adjustment of averages, &c.

MASTER AND OWNER.

What is the master's duty towards the owner of the ship?

The captain's duty to the owner of his ship is that of an authorized agent, as far as that ship, for the voyage, is concerned.

Can the captain be sued for claims against his ship?

Yes; if those claims were incurred during his command, and with his knowledge and consent, or if those debts were of his contracting.

Is the owner bound by the captain's acts?

The owner is bound for every legal act of the captain, regarding the ship and voyage.

How is the owner bound?

In money, to the true performance of all contracts entered into by the captain within the limits of his authority.

What are the limits to the captain's authority?

The captain's authority is limited to the ship which he commands, and for that voyage only.

How can the owner be responsible for the captain's transactions in a foreign port?

The ship and freight are held responsible by those who have claims, though the owner may not be within reach.

What are the incidental powers of the captain?

Those powers which are delegated to him by the simple placing of his name on the register.

Name some of these incidental powers.

When a man becomes master, he has power to ship seamen and officers, and to discharge them at his pleasure, (with the consent of the Consul,) or according to their agreement; to charter his ship in a foreign port, and to do whatever he may consider most beneficial for the interest of the owners, for whom he is the agent.

Can the captain, having money in his hands belonging to the owner, purchase cargo on the owner's account?

Not without special instructions or authority to do so.

Are the owners of a ship bound by the captain's charter in a home port?

The owners are not liable to an action of covenant unless they have let it be understood that their captain was their authorized agent to transact business beyond his power as master of the ship.

What authority has the captain as to the purchase of supplies, &c.?

The owners as well as the captain are liable for supplies.

Is the captain liable for supplies ordered by the owners?

No, never.

What kind of supplies may the captain order on the owners' account?

Such as are absolutely necessary for the furtherance of the voyage, but not such as may be dispensed with, such as luxuries for his own use.

Are the owners liable for goods that may have been shipped, and damaged by neglect, or lost by carelessness?

Yes, and the captain is also personally liable.

Should the captain hire the ship and man her, working her for his own benefit, merely paying the owners the hire, are the owners in this case liable for supplies?

The captain is in this case in the place of owner, and is therefore the responsible person. The owner is not liable for supplies while such a contract exists.

What is the captain's authority as to procuring supplies in a foreign port?

As the captain is in this respect regarded as the general agent of the owner, he may procure what supplies are *necessary*.

What may properly be called necessary repairs, and for which the captain can bind the owners of the ship?

Necessary repairs are those that are indispensable for the safety of the ship, and for the accomplishment of the voyage.

If bills drawn on the owners for proper repairs are dishonoured, will an action lie against the owners for money expended?

Yes, it will.

If a master expends money of his own in procuring repairs or supplies, has he a right to call upon the owners to repay him?

Yes, he has; and he has a right to detain the freight until he is fully paid his disbursements, and any expenses incurred in collecting the same.

Can a captain alter a contract made by the owners?

No, not as commander of the ship.

Can a captain legally pledge the freight to raise money for his own private use?

He cannot.

Are the owners liable for the captain's blunders?

Yes, if those mistakes or blunders are made within his authority.

What is the captain of a ship bound to do for the owners, in consideration of his wages?

He is bound to exercise a reasonable judgment, skill, and care in the management of his vessel, and he and the owners are bound, in like manner, to every one who is affected by his acts in such management.

If a master, from his ignorance or carelessness, injure another ship in entering a port, are the owners liable?

Yes, and the ship commanded by the ignorant or careless captain is also liable for the damage done.

What are the master's duties as regards the receipt, stowage and delivery of goods or merchandise?

First, to have them taken on board with care, and stowed according to the rules (see Stowage of Mixed cargoes, page 42 to 51), and to deliver them according to bills of lading, remembering that they are to be stowed under hatches. If they be carried on deck without the sanction of the shipper, or contrary to usage, the master personally, or the owner, would not be protected from liability for their

loss or damage, unless it can be clearly proved that they would have been lost had they been stowed below.

If lumber be taken on board, and a bill of lading be signed for it, is the carrier bound to stow it away under hatches?

He is; and he is liable for its loss if there be no agreement or custom to justify him in stowing it on deck.

Are goods that are stowed on deck covered by a policy on "cargo and freight," without intimation to the underwriters that such goods *are* on deck?

They are not.

Suppose goods are carried on deck, that by the terms of the charter-party and bills of lading are supposed to be carried below, and are delivered in good order, is the ship entitled to full freight?

No, only deck freight.

Can a wharfinger detain a ship, as having a lien for wharfage?

Yes, he can.

If a ship receives in the course of a voyage such damage as cannot be repaired within a reasonable time, or is condemned, what should the captain do with the cargo?

If another vessel can be procured, either in the same or a neighbouring port, the captain's duty is to hire it and forward the cargo to its port of destination.

If in procuring a ship to complete the voyage the master is compelled to pay a higher rate of freight than he originally agreed for, who bears this loss?

He may charge the owners of the cargo with such extra rate, and collect it with the original freight; the parties concerned must bear the loss.

What is considered an equitable extra rate of freight in such cases?

It is usually considered that the difference between the original freight, (per charter-party,) and the freight at the same ratio to the port of necessity, should be added to the hire of the assisting ship, and both collected from the owners or consignees of the cargo.

Should the consignees refuse to pay such extra freight, what remedy has the master?

He has a lien on the goods, and may retain possession until he is paid.

Could the shipper or his agent claim the goods at the port of necessity, or at an intermediate port?

Yes; but he would be liable for the full freight to the final port of destination.

Should a cargo be found damaged at the port of necessity to such an

extent that it would become totally worthless if carried forward, is the captain bound to fulfil his agreement by carrying it forward to the port of destination?

No; it is his duty to land and sell such cargo for what it will bring; and this holds good, though it *might* have been carried forward and landed.

What is understood by the assertion, that the captain is the agent of, and bound to exercise sound judgment for the benefit of all concerned, in every misfortune?

Simply this; that when a ship loses sails or a mast, or sustains any other trifling damage, and on survey it is found that the ship is indisputably rotten, and the master is convinced of her inability to perform the voyage without very expensive repairs, such as would render the voyage worse than unprofitable, in short, not worth pursuing, he may, after carefully weighing every circumstance and counting the cost, sell the vessel for the benefit of all concerned. If the captain be an honest man, the fact of the ship being insured would not weigh a feather in his decision. Fraudulent or colored statements, or concealments in protests, followed by a hasty condemnation and immediate sale, or extensive repairs, gone into without the usual and *necessary* formalities, and sanction of competent, disinterested surveyors, may embarrass the owners, but will not in the slightest degree increase or extend the legal liability of underwriters. The ship-master's duty to the insurer, as to the insured, is clearly that of an honest servant to an honest employer. But his special duty is to ascertain by the opinion of the surveyors, as well as by his own investigation, what are the damages and the costs of such as are caused by the perils of the sea, *and keep those apart* from all defects or damage arising from other causes, and from inherent weakness or decay of the vessel herself, or any part of her spars or rigging; keeping these accounts apart from those, for the satisfaction of all parties concerned, and to preserve all documents in regular order. It is when all these requirements are complied with, that a ship-master can be said to perform his duty to all concerned, at least if the marine underwriters be considered one of these.

If the ship be condemned, can the cargo be sold by the captain?

Yes; but not without the most mature consideration. It is the captain's duty to forward the cargo to its destination, if it be possible to do so by any practicable method, within reasonable circumstances of time and cost; and should a captain sell his cargo without regard to his duty in this respect, himself and owners would be held responsible.

Should a ship be rendered unfit to complete the voyage, and no ship can be procured to carry forward the cargo, which can find no purchasers in the port of necessity, what then should the captain do with the goods?

It is difficult to give an explicit answer to this question; but the captain, being agent for all, must act according to the best of his judgment. A sale, however, is the *last* resource, prior to which the owners of the cargo should, if possible, be advised, and their instructions procured; for a captain should remember that if he sells without absolute necessity, himself and owners are responsible, and he has *no right* to *sell* goods that are not damaged, without the sanction of their owners. The power to sell cargo in cases of necessity abroad is admitted, but that necessity is not held to exist in a country where the owner resides.

If the master cannot raise money to repair his ship to enable her to prosecute her voyage, has he the power to sell or hypothecate the cargo, or any part thereof?

He has, if it be for the benefit of the cargo, not otherwise; but though the benefit may be more immediately for the ship, yet it may be for the *preservation* of the cargo to repair the ship, and therefore it *may* be done for the *benefit* of both cargo and ship.

When a part of the cargo is sold, consisting of the goods of one or two merchants, can these merchants claim from the owners of the ship indemnity for their loss?

Not exclusively. They have a claim against other owners of cargo as well as against the owners of the ship.

What power does the law give the master of a ship as to the sale of his vessel?

The master is justifiable in selling his vessel if, from any combination of causes, she is found to be so impaired as to render it unsafe to proceed on the voyage without such enormous repairs as would cost more than she would be worth in her home port when completed, and the means to pay for which would be out of his power, or if the repairs would amount to more than a prudent man would be willing to incur were the property his own.

Are all vessels required to take pilots in entering or leaving ports?

Yes; a ship cannot be considered properly navigated within the implied warranty of seaworthiness without a pilot while in pilot water; but if there be no licensed pilots, then anyone having local knowledge may be employed.

Is the captain of a ship answerable for his own errors in judgment?

Yes; he is supposed to be master of circumstances, and therefore *bound* to possess such knowledge as will enable him to use reasonable care and attention, prudence and fidelity, as an *expert* in his profession, and if any "misfortune" or mischief befal his ship or the cargo on board from a want of that knowledge, or from the ignorance of his officers or crew, he is held responsible therefore in a CIVIL ACTION; and if owners suffer damage on that account, they can recover the same from the master.

May an owner of a vessel discharge a master at his pleasure?

If a master has just completed a voyage, or has been appointed, but the voyage has not yet commenced, or the captain has not signed bills of lading he may be dismissed without any reason being assigned; but if the voyage has commenced and the captain has signed bills of lading for the cargo, he cannot be discharged without compensation, proportionate to the damage sustained by him; unless the discharge be for good and sufficient cause, such as incompetency, repeated intoxication, wilful neglect of duty, or actual fraud committed; the extent of the damages cannot exceed the wages for the voyage, if the dismissal takes place in a home port.

Can an owner legally discharge a master abroad?

No; unless it be for drunkenness or other bad conduct, which must be proved to the satisfaction of the Consul or other public agent; and *even then* the owner is liable to an action for damages, unless he furnish the captain so dismissed, with a free and immediate passage home.

Should the captain *with the consent of the owner* enter into such speculations on his own account, as would render a summary dismissal from the ship disastrous to the captain's interest, would the owner be liable for such loss?

Yes; if it were made to appear that the privileges to trade, &c., were a part of the captain's remuneration for his services as master; the owner dismissing such master without sufficient cause, would be liable for such damages as could be proved, in addition to the full amount of wages for the entire voyage.

Are masters of ships bound by law to have proper medicines on board for their crew?

They are.

What is the penalty for not having such medicines on board?

In default of such medicine-chest and such medical knowledge on the part of the master, he is liable to provide all such advice, medicines, and attendance of physicians, as the crew may in case of sickness

require, in any port, without any deduction from the wages of such seamen.

When the vessel is let to the master on shares without reserving any control over her, is the owner liable for wages?

He is not. But the men have a lien on the ship for wages.

What do the perils of the sea mean?

Every accident happening by the violence of the wind, force of the waves, lightning, fire, submarine volcanic action, pirates, rovers, enemies, striking on rocks and shoals, and accidental stranding, may be considered the dangers of the sea.

Is the underwriter liable for losses arising from all these causes?

He is, unless specially exempt from one or more of them in the policy.

If rats cut a hole in a ship, by which she becomes leaky, who will be responsible?

The underwriter, unless the owner refuses to use the means of exterminating the rats. This is one of the dangers of the sea.

Are losses by worms, or the animal called the "Teredo," reckoned as dangers of the sea?

No; because this may be prevented by copper.

What is the law as to the ship's articles?

The law requires that all seamen shall sign an agreement, as to the beginning and termination of the voyage, the ports bound to, the rate of wages, and the time the men are to be on board. Such articles must be read to the crew.

Who is responsible for the wages of seamen?

The owner of the ship in which such seamen have served, and the men have a lien on the ship until paid.

Are seamen common creditors in case of an owner's insolvency?

No. The seamen's wages are paid first in proceeding against the ship.

If the cargo, too, belong to the owner of the ship, is it bound or liable for wages?

Yes.

How is this claim to be enforced against freight?

By attaching or seizing it in the hands of the captain or merchant before it is paid.

What change in the position of a captain does an abandonment by him produce?

If made on proper and sufficient grounds, he (the master) ceases to be the agent of the owner as far as the interest insured is concerned, and he becomes the agent for the underwriter from that hour.

If a mate, by the death of the captain, becomes captain, and ceases to be a mate, does he lose his lien for wages as mate, when the owner refuses to pay him as master ?

No; he can sue for mate's wages for the whole voyage, but not for more ?

What remedy has a master for the recovery of his wages ?

A captain has now the same lien upon the ship for his wages as a seaman, and can attach the vessel until settled with. But the owner or agent can give bond for settlement, and release the ship.

What is understood by a ship's husband, and what are his duties ?

It is usual, where there are many owners to one ship, or one owner has many ships, to appoint a man in whom they can confide to manage the ship's business. He is required to see that the ship is properly fitted, equipped, and managed with economy and propriety. His duties and powers are often defined and limited by the terms of a special agreement. Where no such agreement has been made, he is to exercise an impartial judgment in the employment of tradesmen, and the appointment of officers, and be careful in his selection of masters; he is required to see that the ships are properly equipped and manned, to procure freights, make charter-parties if required, adjust freights and averages, disburse and receive moneys, and adjust and check all accounts between the parties interested. His acts for these purposes are considered to be the acts of the owners, who are legally liable for all contracts entered into by him for the conduct of their common concern—the proper fitting and supplies for the ships.

MASTER AND UNDERWRITER.

Is it lawful for a captain to touch or stay at any port not named in his clearance, or bills of lading ?

No; nor can he do so without committing a "deviation from his voyage."

What is the consequence of a "deviation from the voyage" specified in the charter-party and policy of insurance ?

In case of the ship being then or subsequently lost, the underwriters would not be liable (unless they undertake such risk), and the policy would be void.

Are there any circumstances that would justify a deviation ?

To justify a deviation, the necessity must be real, inevitable, and imperious; and the ship must not be detained, or the deviation prolonged, one moment after the necessity has ceased. A deviation

without such imperative necessity vitiates all insurance upon the ship and cargo, and exposes the owners to an action on the part of the freighters for any loss that might arise from a falling market and deterioration in value in consequence of delay.

Is the captain accountable for damage arising from bad stowage?

He is.

What is meant by the term seaworthy?

It means that the ship is in *every* respect fit for the intended voyage —that is, that she is *stiff*, tight, staunch, strong, properly rigged fitted, and trimmed for the voyage; that she has a sufficient number of competent seamen to work her under the most adverse circumstances; that the captain and officers shall be not only thoroughly acquainted with every branch of seamanship and navigation, but have the proper instruments, books, and charts, to enable them to perform their duties in a proper manner.

Should the ship or officers be deficient in any of these particulars, would the owners be liable for damage arising from such deficiency?

Yes; the underwriters would be exonerated from any liability, as the insurance was effected with the understanding that the ship should be in *every way* seaworthy and properly manned, and fit for the voyage. But if the ship be seaworthy at *starting*, the owners have done their duty in this respect.

Are seamen's wages insurable?

No.

Are mates' wages insurable?

No; but a mate may insure goods purchased with his wages, the goods being regularly shipped.

Can a captain insure his wages, commissions, and privileges on board?

He can.

What is barratry?

Any fraudulent conduct of the master, or mariners, toward the owner, and it includes any breach of trust committed with dishonest intentions; such as trading with an enemy, sailing from a port without paying port dues, thereby laying the ship liable to seizure; going out of the regular course of the voyage, on an unlawful expedition, or smuggling; sinking the ship, or running on shore with intent to defraud, or doing any act that would render the ship or cargo liable to confiscation.

Does a mere breach of contract on the part of the master constitute barratry?

No, it does not.

What effect has barratry upon a policy of insurance?

It leaves the underwriters liable for the loss, unless they are specially exempt therefrom, by a clause in the policy.

Is stopping, or going out of the way to relieve a vessel in distress, a justifiable deviation?

In some cases a vessel may deviate from her course for this purpose without violating her insurance.

Suppose there are more ports than one or two named in the policy, how should the captain proceed?

He must go to those ports in the order in which they stand in the policy.

Is a deviation and the alteration of the voyage the same thing?

No; the alteration of the voyage usually takes place before the commencement of the risk; whereas, a deviation takes place after the risk has commenced; and is in violation of the plan agreed on, in the policy.

If a captain takes more cargo, or of a different description from what was named in the policy, what would be the effect?

The underwriters are not liable for the loss or damage of such ship or cargo, if the risk is thereby increased.

Will an unwarrantable delay amount to a deviation?

It will.

If a crew be shipped for a voyage, to two or more ports named, and the captain or owners choose to break up the voyage at the first port, what wages are due to the seamen?

The seamen and officers will be entitled to full wages for the whole voyage named in their agreement.

In case of shipwreck, are seamen entitled to their wages?

Seamen are entitled to their wages if the ship has earned freight, up to the last delivery port, and if it appear that they have done their duty faithfully, and up to the day of the wreck; provided there be enough saved to pay such wages, not otherwise; though if goods be saved, seamen have a lien on them as for salvage, to the amount of their wages.

What precaution is necessary in signing bills of lading for gum shilac, (button lac)?

The master should sign "not accountable for damages arising from the lac running together, or becoming solid, from warmth."

What precaution is necessary in taking shilac on board?

The cases should be examined to ascertain the state of the goods, as this article is often *shipped* in a partial solid state; if this is found to be the case, the fact should be mentioned in the bill of lading.

GENERAL AVERAGE.

What is meant by the adjustment of a general average?

In ascertaining the amount of claim, and in determining the respective shares of contribution.

What is the general average?

A general contribution by all parties concerned towards a loss sustained by some of the parties interested, for the common benefit.

What is particular average?

Damage or loss incurred by a part of the concerned, which must be borne by that part alone.

How do you distinguish between those losses which belong to, or are to be paid by general average, and those that belong to, or must be borne by the party alone?

In order to render a general average possible, a sacrifice must be made for the general good, such as throwing cargo overboard to lighten the ship; masts cut away to save the ship from capsizing; the ship run ashore to escape from an enemy, or a pirate, or running for a harbour of refuge to save the ship and cargo from sinking. All accidental damages, or dangers by the sea, or fire, are particular average.

What is meant by jettison?

Whatever the captain of a ship does in distress for the preservation of the whole, as throwing cargo overboard, cutting away sails or masts to right his vessel, should she be thrown on her beam ends.

What expenses or charges consequent on damage can be recovered by a general contribution or general average?

Every expense arising in consequence of a damage, and also the wages and provisions of the crew and labourers it may be necessary to employ, from the time the course is altered to run for a harbour of refuge, together with pilotage, wharehouse dues, wharfage, harbour dues, lights, and towage, until the surveyors pronounce the ship tight, stiff, staunch and strong, and fit to proceed on the voyage, are chargeable to, and recoverable by general average.

Why should all parties concerned contribute to a loss sustained only by the ship's owner?

Because all are concerned, the ship, the freight, and the merchandize, and if the sacrifice were not made, all might be lost.

Is the sum agreed to be paid to fishermen or other boats, for bringing the ship safely into port in a sinking state, payable by general average?

It is.

Are the expenses of getting a ship off and of repairing her when she has been run on shore purposely, payable by general average ?

When the situation of the ship is such that notwithstanding the fury of the winds and seas, the captain can choose the place of stranding, and benefits are likely to result from changing the course of the ship, or if by running to a part of the coast where comparatively small damage is done, or where the cargo may be saved more readily than it would have been had the ship drifted on shore before the gale, then the expenses of getting her off and repairing are assuredly payable by general average.

Are ropes, sails, &c., used or cut up to stop leaks, in cases of damage, payable by general average ?

They are, if they were required for the general safety; and in general, all sacrifices, of whatever kind, when made for the general good are recoverable by general contribution.

Name some of the particular average losses that are likely or liable to arise in the course of a voyage.

Fire, starting a butt, loss of rudder, splitting sails, carrying away masts or sails.

What is the rule with reference to general average as to money which the captain is obliged to raise abroad, in order to enable him to prosecute his voyage?

It is generally admitted that all charges and expenses, including commissions, shall be added to the cost of repairs and paid by general average, but those expenses which belong to particular average should be kept separate and deducted from the whole amount.

What must contribute to the general average ?

The ship, freight, and all the merchandize on board.

How is the value of goods, &c., to be estimated in adjusting a general average?

The merchandize is valued at the market price at the port of destination, or where the average is adjusted; the ship at her value after the repairs have been made.

How is the value of a lost ship estimated?

A ship is valued by what she was worth on sailing from her home port, deducting a reasonable amount for wear and tear up to the time of her disaster.

How are losses of the equipment of a ship estimated, they being new?

It is usual to replace them with new, deducting one-third of the cost.

If a ship being damaged be sold in a foreign port, how is her value to be calculated in contribution?

At what she actually sold for.

At what place should the average be adjusted?

At the port of destination, or where the cargo is delivered.

Why should the average not be adjusted at the port of necessity?

Because an adjustment at an intermediate port, without the knowledge and consent of the parties concerned, would not be binding upon any one.

Is the captain obliged to deliver the goods before the sums payable in respect to them is either paid or secured to him?

No; he should hold all goods until each person having interest in his cargo has either paid his contribution, or signed a bond to do so.

Has the captain then a lien upon the goods for the payment of the contributions?

He has.

What should the captain do where there are many consignees, and the average is not yet adjusted?

It is usual in such a case to require a bond from the several merchants for the payment of their proportions of the average, when the same shall be adjusted.

If the captain were to part with the goods (without such bond), could he afterward recover the contributions?

No.

Does freight contribute to general average?

All freight that is depending on the safety of the ship for that voyage must contribute according to the *clear amount* of *earnings* of the voyage after deducting the wages, provisions, and other expenses of the voyage.

What is the rule for ascertaining the amount to be deducted for the wages, provisions, &c.?

It is usual to deduct one-third from the gross amount.

PARTICULAR AVERAGE.

By whom is a particular average loss to be borne?

By the owner of the thing damaged or lost.

What is the difference between a partial loss and a particular average?

The term "particular average" is used to signify the mode of adjusting a loss on goods, arising from the article being deteriorated in value in consequence of its being sea damaged; and the term "partial loss" to signify a total loss of part of the thing insured.

Is the premium of insurance considered as part of the value of the goods?

It is.

What is the rule for adjusting a partial loss?

It must be paid for at cost, as if a total loss of the whole had occurred; if one hogshead of sugar be totally lost, it is paid for by the underwriters or parties concerned.

What is the rule for adjusting a particular average or partial loss on the ship and materials?

To apply the old materials towards the payment of the new, by deducting their value, and then deducting one-third new for old on the balance.

What are the principal losses that belong to particular average?

Splitting sails, parting cables, starting butts, springing masts, accidental touching on the ground, ship being strained, loss of boats, diminution of value, tearing sheathing, carrying away stanchions, being struck by lightning, fire, collisions, and all consequent expenses and losses arising from damage by the dangers of the sea.

Is the expense of raising funds to pay repairs on a particular average at risk of underwriters?

It is, in proportion to their liability.

Is any deduction made on anchors and cables?

None.

What is the rule for adjusting a salvage loss?

Underwriters pay a total loss and take the proceeds of the goods.

BOTTOMRY BOND.

What is a bottomry bond?

A bottomry bond is a contract by which the captain or owner of a ship borrows money to enable him to carry out the voyage, and by which he pledges the keel of the ship as security for its repayment; or for money loaned at a high rate of interest on great marine risks, to be run by the lender.

In what case can a captain legally bottomry his ship?

The captain can hypothecate his ship *only* when he is at so great a distance from his owner that it is inexpedient and unreasonable to delay for instructions or funds from his owner, and then *only* to raise money to save the ship and to prosecute the voyage; *and there is no other way to raise funds.*

If a ship be lost will the lender on bottomry lose his money?

He will unless he is insured.

Can a captain spend the money he receives on bottomry as he pleases?

No; only for the repairs and reasonable supplies of the ship, to enable her to proceed on her voyage.

Is the captain justifiable in advancing money to his crew, on account of their wages, out of monies thus obtained?

No; nor can he legally apply any part of such money to his own use

What is the difference between bottomry and respondentia?

The first is a loan upon the ship, the second upon the cargo. In the former, the ship and tackle are liable for the money borrowed; in the latter, for the most part, recourse must be had to the person of the borrower. In a loan upon bottomry the lender runs on risk, though the cargo should be lost; but in the case of a respondentia, the lender will receive his principal and interest, though the ship *be* lost, provided the cargo be saved.

In all other respects are bottomry and respondentia the same?

They are.

What are the risks to which the lender on bottomry exposes himself?

They are generally mentioned in the conditions of the bond, and are nearly the same as those undertaken by the underwriters; but he is exposed to the extra risk of second, and even third bottomry.

Can bottomry and respondentia interest be insured?

They can, by declaring that the risks are such.

What is the rule as to the authority of the Captain to hypothecate the cargo?

If he has no funds and can obtain credit only on extremely exorbitant terms, he may resort to the hypothecation of the ship and pending freight; and if these do not suffice, then he may hypothecate the cargo also.

Does the sale of the vessel by the master, in a foreign port, defeat a prior bottomry bond?

It does not.

What is the interest of a borrower on bottomry and respondentia?

The borrower on bottomry or respondentia may have an insurable interest in the property pledged, no less than a mortgager, but with this distinction—that the mortgager remains liable for the whole loss upon the goods; if they be lost, no part of his debt is discharged. Whereas, if the hypothecated ship or goods be lost, the borrower is discharged from his debt.

Can the captain pledge the ship itself, and on the personal credit of the owners?

He cannot. The owner is not personally bound by the bottomry.

Can a person who is indebted to the owners of a vessel, lend money to her commander on bottomry?

He cannot; as he should pay his debt, and then there would be no necessity for a bond. If, however, his debt be less than the sum required, or by him advanced, the bond would be valid to the amount of the surplus.

Is there any settled form of contract in use on these occasions?

There is not; a bond on a bill of sale, &c., is given, but all the particulars should be set forth, whatever the form adopted.

Can a captain pledge his ship in a home port?

The distinction between home and foreign ports, ought not to rest so much upon the government of the country, as on the proximity and facility of communication between the places where the captain is called upon to act, and the place where the owner lives.

When freight is pledged on a bottomry bond, does it mean the freight for the whole voyage?

It does; and not merely the freight for that part of the voyage unperformed at the date of giving the bond.

If the captain has money on board as cargo, belonging to shippers; is he bound to apply it to the ship's purposes, to avoid raising money on bottomry bond?

He is not bound to do so, but the law invests him with a discretion in this matter. If the amount on bond be not equal to his necessities perhaps it would be better not to do so; but when the rates of interest demanded are too high, every judicious ship-master would apply his cargo (being coin) to the purposes of defraying his expenses.

QUALIFICATIONS FOR MASTERS ORDINARY.

In addition to all the foregoing, *every* master of a foreign going ship should understand the following problems in nautical science, viz.:— To calculate the altitudes of the heavenly bodies; to find the longitude by lunar observations; to rate chronometers; the use of the artificial horizon; and to find the course and distance between places, and between his ship and any place by great circle sailing.

PROBLEM 36.

To calculate the true and apparent altitude of the sun at any given time and place, thus:—

Required the true and apparent altitude of the sun's centre at 4h. 27m. 45s. P.M., on June 12th, 1865, in latitude 39°.17′ N. and longitude 76°.36′ West.

	H. M. S.
Time at ship, June 12th, 1865	4 27 45
Longitude, 76°.36′ W., in time...	+ 5 06 24
Time at Greenwich, June 12th, 1865	9 34 09

Sun's declination at Greenwich, Noon, June 12th ...	23°.10′.44″.5
Correction for 9h. 34m. 09s. × 9s.21 ... +	1.28
Sun's true declination at Greenwich time	23 . 12 . 12 . 5

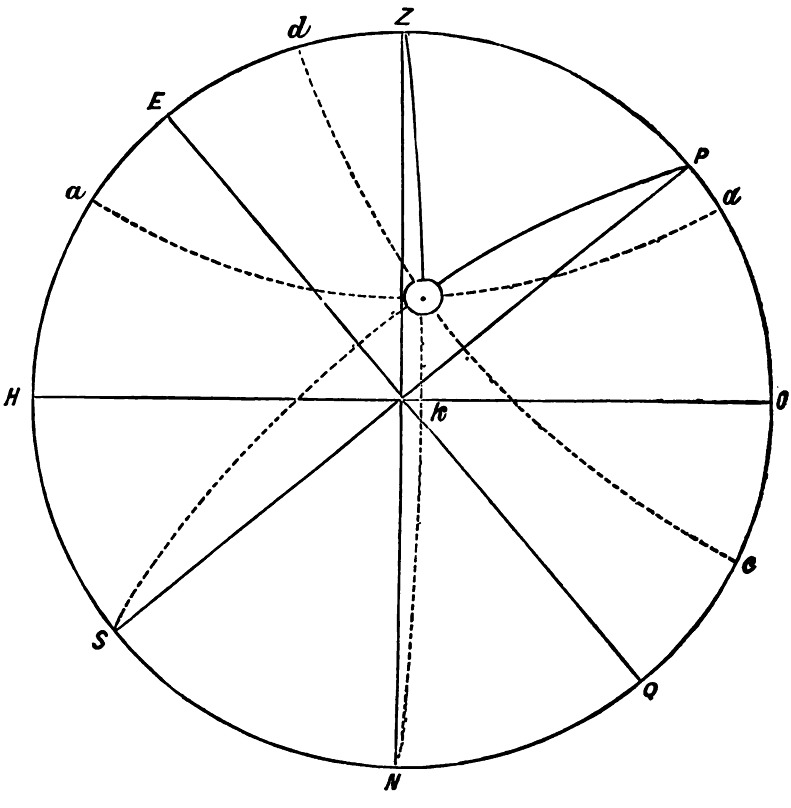
Apparent time at ship, 4h. 27m. 45s.		Log rising	4.78409
Latitude of ship	39°.17′.00″N.,	Log co-sine	9.88875
Declination	23 .12 .12 N.,	Log co-sine	9.96337
Natural number		43272	Log. 4.63621
Diff. lat. and declin.	16 .04.48	96087 Nat. co-sine	
Sun's true central altitude, 31°.52′.48″	=	52815 Nat. sine	
Refraction ... ... +	1.31		
	31°.54′.19″		
Paralax ... ... —	8		

Sun's apparent altitude 31 . 54 . 11 June 12th, at 4h. 27m. 45s., in Longitude 76°.36′ West, and Latitude 39°.17′ North.

Solution by Construction.

With the chord of 60° describe the primitive circle Z H N O to represent the meridian, in which Z represents the zenith, and H O the horizon. Make O P equal to 39°. 17′, the latitude. Draw the axis P S, and equator E Q; make Q *c* and E *d* = to 23°. 12′. 12″, the declination, and with the co-secant of the declination describe the parallel circle *d c*. With the tangent of the time from noon = 66°.56′.15″, describe the hour circle P ⊙ S. The intersection of this circle with the parallel *d c* shows the sun's place at the given time; describe the vertical circle Z ⊙ N. Now the arc ⊙ *k*, represents the true altitude = 31°. 52′. 48″; and ⊙ Z is = to the zenith distance = 58°.07′.12″.

Construction.



Solution of same by Spherical Calculation.

In the spherical triangle P Z ⊙ we have two sides, and the included angle given, to find the third side, viz., P Z = co-lat. = 50°.43′. The side P ⊙ = polar distance = 66°.47′.48″, and the included angle, ⊙ P Z = 66°.56′.15″ = 4h. 27m. 45s. to find the third side or zenith distance = 58°.07′.12″. This taken from 90° leaves the true altitude of the sun's centre, thus:—

As radius	90°		10 00000
Is to ∠ P,	= 66.56.15	Co-sine	9.59299
So is leg P ⊙	= 66.47.48	Tang.	10.36788
To 1st arc	... ... 42°.25′.22″	Tang.	9.96087
Side P Z	... ... 50 .43 .00		
Arc 2nd	... ... 8 . 17 . 38		

As arc 1st = 42°.25′.22″	... ...	Co-sine	9.86817
Is to arc 2nd = 8 .17 .38	... ...	Co-sine	9.99543
So is P ☉ = 66 .47 .48	... ...	Co-sine	9.59548
			19.59091
To Z ☉	58°.07′.12″	Co-sine	9.72274
Which taken from	90 .00 .00 leaves		
Sun's true altitude	31 .52 .48		

Agreeing precisely with the former mode of calculation, and also with the construction.

PROBLEM 37.

Required the true and apparent altitude of the moon's centre' February 4th, 1865, in latitude 45°.25′ N., and longitude 20°. 36′ W., at 5h. 40m. P.M.

		H.	M.	S.
Time at ship, February 4th, 1865		5	40	00
Longitude in time = 20°. 36′ W.	+	1	22	24
Time at Greenwich, February 4th ...		7	02	24
Sun's right ascension, Feb. 4th, Noon, G. T.		21	12	56
Correct for 7h. 2m. 24s. and 10s.072 = ...	+		1	11
Sun's correct right ascension		21	14	07
Time at ship, Feb. 4th, 1865		5	40	00
Right ascension of meridian		2	54	07
Moon's right ascension, Feb. 4th, at 7h. 2m. 24s.		4	25	41
Moon's distance from meridian		1	31	34

Moon's dist. from meridian = 1h. 31m. 34s. its Log rising			3.89636
Latitude	45°. 25′. 00″ N.	... ... Co-sine	9.84630
Moon's declination	18°. 49′. 25″ N.	... ... Co-sine	9.97613
Natural Number		5233 = Log.	3.71879
Diff. dec. and lat.	26°. 35′. 35″ N.	89422 Co-sine.	
☽'s true altitude 57°. 20′. 27″		84189 Nat Sine.	
☽'s correction —	30 . 18		

☽'s app. altitude 56 50 09 4th Feb., 1865, at 5h. 40m., P.M., in latitude 45°. 25′. 00″ N., and longitude 20°. 36′ W.

It must be remembered that it is the *apparent* altitudes of the sun, moon, stars, or planets that are to be used in finding their true distance from the moon, in order to deduce the longitude therefrom.

The spherical calculation, and construction of this problem, will be found in every particular the same as the last.

PROBLEM 38.

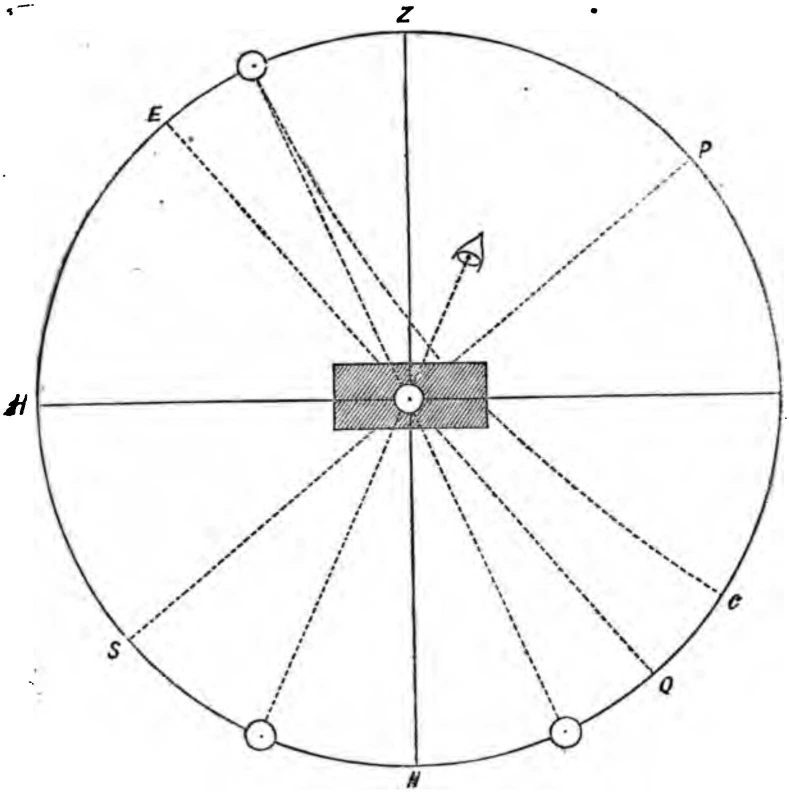
TO FIND THE LATITUDE BY THE SUN'S MERIDIAN ALTITUDE, OBSERVED ON SHORE, BY MEANS OF AN ARTIFICIAL HORIZON.

On the 1st day of May, 1860, the meridian altitude of the sun, as reflected in an artificial horizon, was 131°.31'.42" (double angle), the latitude of the place by account being 39°. 16' North, and longitude 79°.36 West. Required the latitude.

Observed double angle		2) 131°. 31'. 42" S.
½ observed angle=altitude above horizon ...		65 . 45 . 51
Sun's semidiameter	+	15 . 54
Altitude corrected for semidiameter		66 . 01 . 45
Refraction for 66°.	—	25
Sun's apparent central altitude		66 . 01 . 20
Correction for paralax	+	4
Sun's correct central altitude...		66 . 01 . 24
Subtract from		90 . 00 . 00
Sun's true zenith distance		23 . 58 . 36 N.
Sun's declination, May 1st		15 . 17 . 40 N.
Latitude of place of observation		39 . 16 . 16 N.

NOTE.—The horizon may be composed of any substance such as molasses, coal tar, or black varnish, if mercury is not to be had, and placed in *any* position so that the sun's, star's, or moon's image can be seen in it. Invariably divide the observed angle by 2 before the corrections are applied.

Construction.



PROBLEM 39.

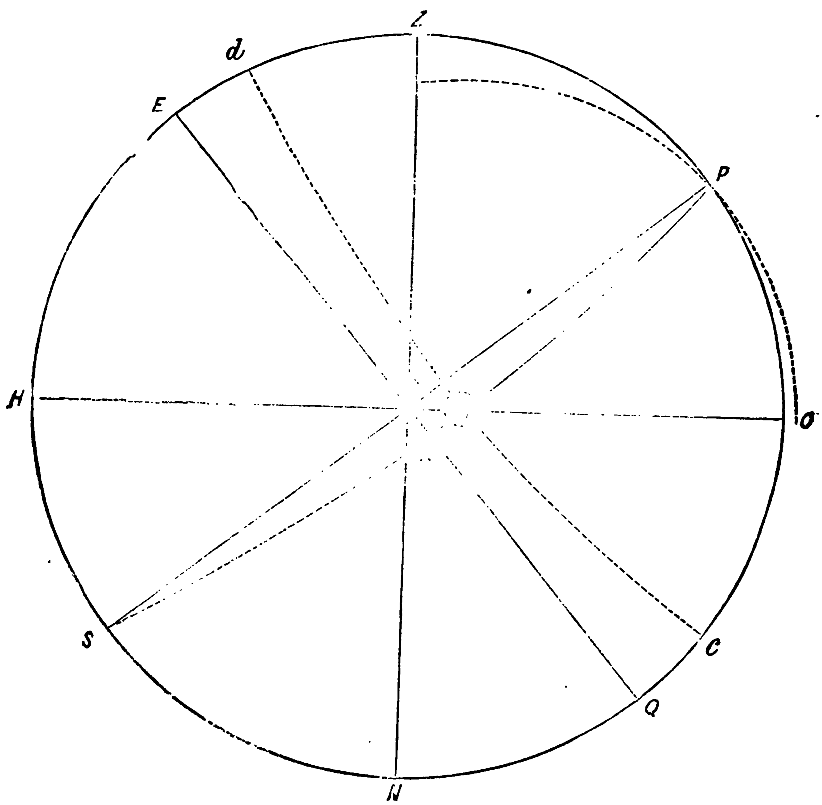
TO FIND THE LATITUDE BY THE BEARING OF THE MOON AT SETTING.

Being at sea in the North Atlantic on a day when the moon's declination at the time of her setting was 13°.00′ North, she bore by azimuth compass, when 14′ above the horizon by the quadrant, 30° to the North of West. The compass having 14°.2′ West variation. Required the latitude of the ship.

Observed magnetic amplitude W.	30°.00′ N.
Variation W.	14 .02
Moon's true amplitude W.	15 .58 N.

As true amplitude		15°.58′	Log co-sec.	0.56056
Is to radius	...	... ...	...	10.00000
So is declination		18°.00′ N.	Sine	9.35209
To co-latitude	...	54 .52	... Sine	9.91265
		90 .00		
True latitude	=	35 .08 North.		

Construction.



Having described the primitive circle Z H N O, draw the horizon H O; and take ♈ ☽ =15°.58′. Then about ☽ as a pole, describe a small circle at the distance of 77°, which will cut the primitive circle in P, the place of the pole; draw the axis P S, and the equator E Q describe the parallel of declination *d c*. Now Z E, O P and H S

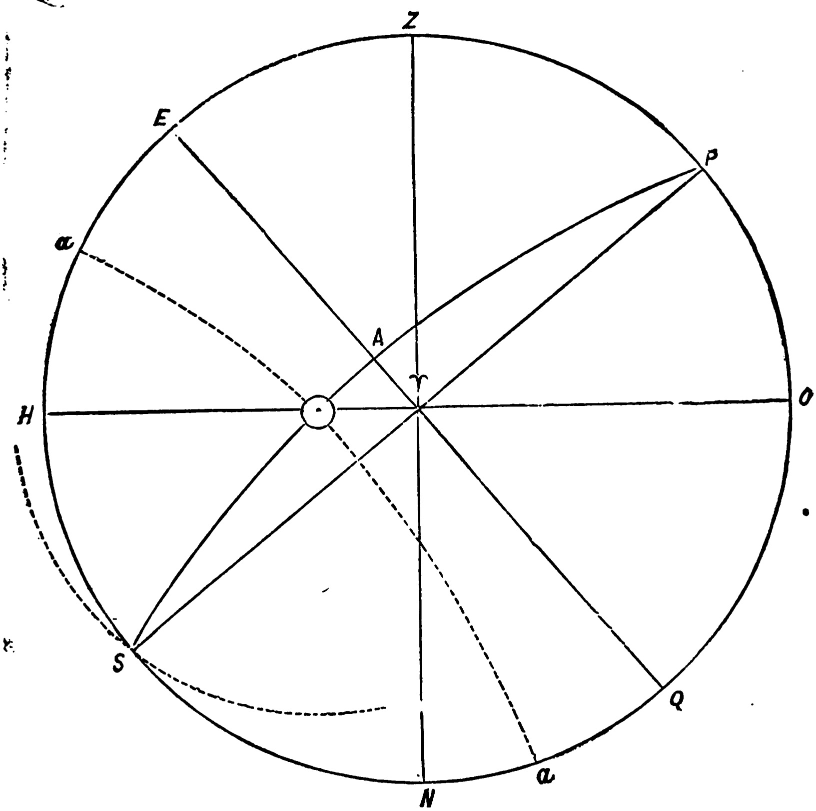
express the latitude=35°.08′, on the line of chords. And by calcula tion, as sine ♈ ☽ =15°.58′ : R : : sine A ☽ =18° : co-latitude=E H and Q O=54°.52′. Hence the latitude 35°.08.′

PROBLEM 40.

TO FIND THE LATITUDE BY THE BEARING OF THE SUN AT RISING OR SETTING.

On the 22nd of December, when the sun's declination was 23°.28′ S., he was observed to rise 45°.49′ south of east by an azimuth compass which had 15°. of error westerly. Required the true latitude.

Construction.



Observed bearing of the sun at rising	...	E 45°.49′ S.
Error of compass, variation west ...	...	15 00
True bearing of sun's centre ...	...	E 30 . 49 S.

As true amplitude ...	30°.49′.	Ar. Co. log sine	0.29038
Is to radius	... ...	... ...	10.00000
So is declination ...	28 .28 S.	Log sine ...	9.60012
To co-latitude ...	51 .00	Log sine ...	9.89050
	90 .00		
True latitude ...	39 .00 North.		

Having described the primitive circle draw the horizon H O, and lay off the true amplitude ♈ ☉=30°.49′. Then about ☉ as a pole, describe a small circle=the sun's south polar distance 66°.32′, cutting the primitive in S, the south pole; draw the axis P S, and at right angles thereto the equator E Q; draw also the prime vertical Z N, and describe the parallel of declination *a a*, with the secant of the complement of 28°. 28′, and it is done, for Z E measures the latitude 39°.

By calculation as amplitude ♈ ☉ = 30°.49′ : R : : declination A ☉ : co-latitude HE=51°.00′. Hence the latitude is 39° north.

PROBLEM 41.

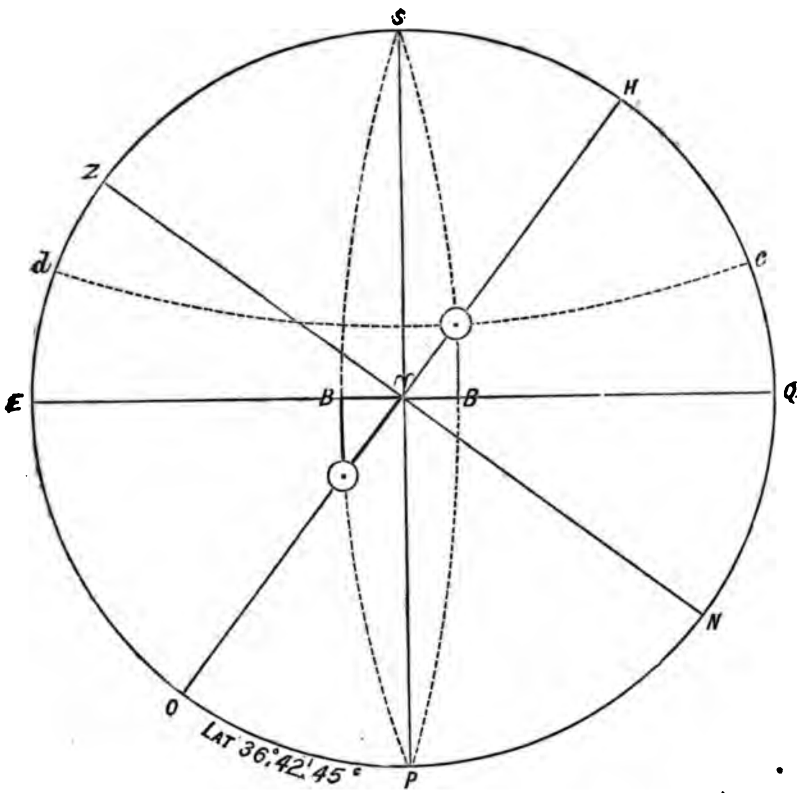
TO FIND THE LATITUDE BY THE SUN'S ASCENSIONAL DIFFERENCE AND DECLINATION.

• When the sun's declination was 20°. south, he was observed to set at 4h. 57m. P.M. Required the latitude of the ship.

	H. M.
Observed time of sun's setting	4. 57
Subtract from	6. 00
Sun's Ascensional difference ... ... 15°.45′=	1. 03

In the primitive circle representing the meridian of the place, draw the equator E Q, the axis S P, the parallel of declination *d c* = 20° South, make ♈ B = 15°.45′, the ascensional difference; describe the circles of right ascension S B P, cutting *d c* in ☉. Then a diameter H O through ☉ will be the horizon, and H S and O P the latitude= 36°.42′.45″ North.

Construction.



By Computation.

Then as radius			10.00000
Is to declination	...20°. 00′ S. ...	Co-tang.	10.43898
So is ascensional difference	15 .45 ...	Sine	9.43367
To co-latitude ...	53°.17′.15″	Co-tang.	9.87260
	90 00 00		

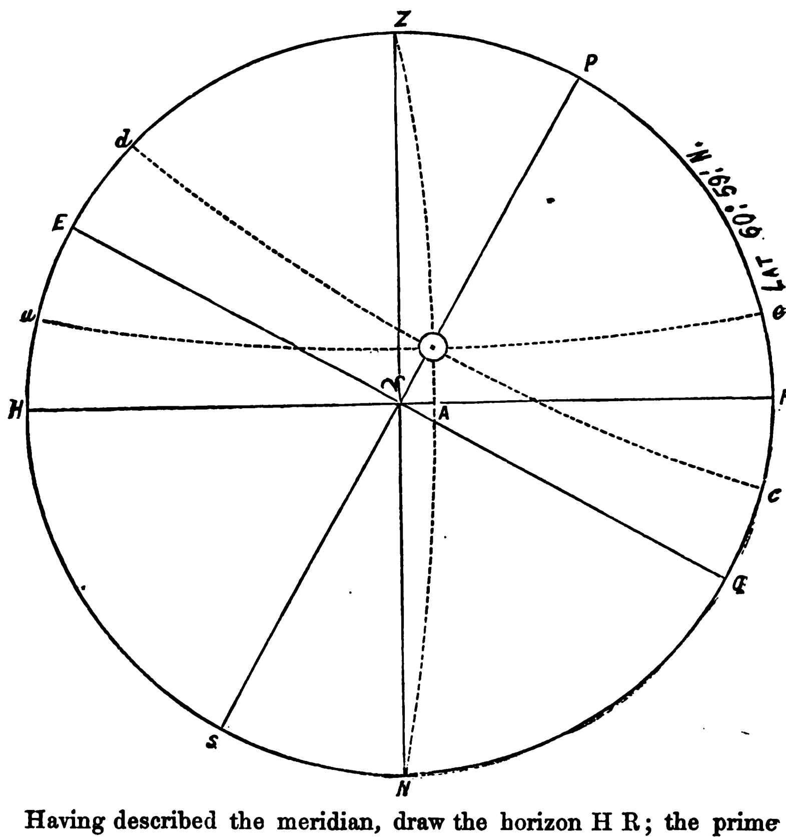
Latitude ... ... 36 .42 . 45 North, because the ascensional difference falls between noon and six o'clock, which must be the case, when the declination is of a different name from the latitude, and *vice versâ*.

PROBLEM 42.

TO FIND THE LATITUDE BY THE SUN'S ALTITUDE AT SIX O'CLOCK, BY A WATCH PREVIOUSLY REGULATED TO TRUE TIME AT SHIP.

Being at sea on a day when the sun's declination was 14°.36′ N., the sun's altitude at six o'clock was, when corrected for dip., refraction, and paralax, found to be 12°.44′. Required the latitude of the ship.

Construction.



Having described the meridian, draw the horizon H R; the prime vertical Z N, and the parallel of altitude *a e*, = 12°.44′. From the centre ♈, with the half-tangent of the declination, = 14°.36′, cut the parallel *a e* in ☉. Through ☉ draw the axis P S, and the azimuth circle Z ☉ N, and the measure of R P will give the latitude = 60°.59′.

By Computation.

As the declination ♈ ☉ = 14°.36′ Ar. Co.,	Sine	0.59848
Is to radius	...	10.00000
So is altitude, A ☉ = 12 .44 ...	Sine	9.34324
To latitude ∠ ☉ ♈ A = 60.59 N., ...	Sine	9.94172

PROBLEM 43.

TO FIND THE LATIUUDE BY THE ALTITUDE OF THE SUN, WHEN HE IS DUE EAST OR WEST, HAVING THE CORRECT DECLINATION GIVEN.

Being at sea on a day when the sun's declination was 6°.42′ N., his true central altitude, when he bore due East, was 11°.17′. Required the latitude.

As the altitude	11°.17′ Ar. Co.,	... Log sine	0.70850
Is to radius ...	... ...	...	10.00000
So is the declination	6°.42′ ...	... Sine	9.06696
To latitude ...	... 36°.36′.20″. N.,	... Sine	9.77546

which is North because the declination is North.

Note.—In all these observations it is absolutely necessary that the errors of the compass should be known. Therefore frequent azimuths and amplitudes should be taken.

PROBLEM 44.

A ship sails for 24 hours in a current setting S. S. E. ¾ E. at the rate of 1¾ miles per hour, and makes by the log 96 miles on a South-West by West, true course by compass. Required her difference of latitude and course made good, with distance and departure.

	S.	W.
24 hours at 4 miles per hour = 5 points 96 miles gives	53.3 and	79.8
Current 1¾ miles in 24 hours gives 2¾ points 42 miles gives	36.0 &	—21.6 E.
These give distance 107 miles; course, 33° nearly,	89.3	58.2 W.

and departure 58.2 West.

PROBLEM 45.

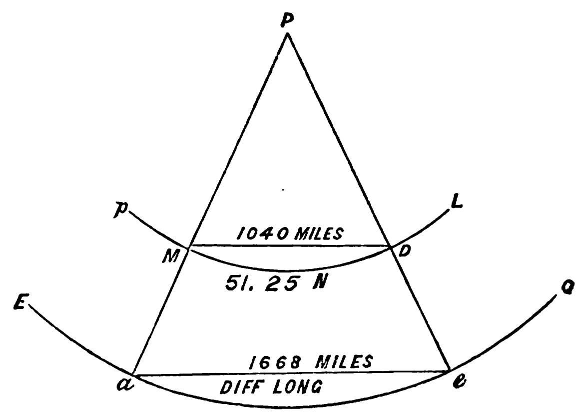
A ship in latitude 51°.25′ N. and longitude 9°.29′. W., sails West, 1040 miles. Required the longitude of the ship?

Computation.

As co-sine of latitude, 51°.25′	... ...	Co-sine	9.79494
Is to the distance, 1040 miles	... .	Log.	3.01703
So is radius ...	... ...		10.00000
To difference longitude 60) 1668	... ...	Log.	3.22209

Difference longitude	...	27.48 W.
Longitude left	+	9.29 W.
Longitude in	... ...	37.17 West.

Construction.

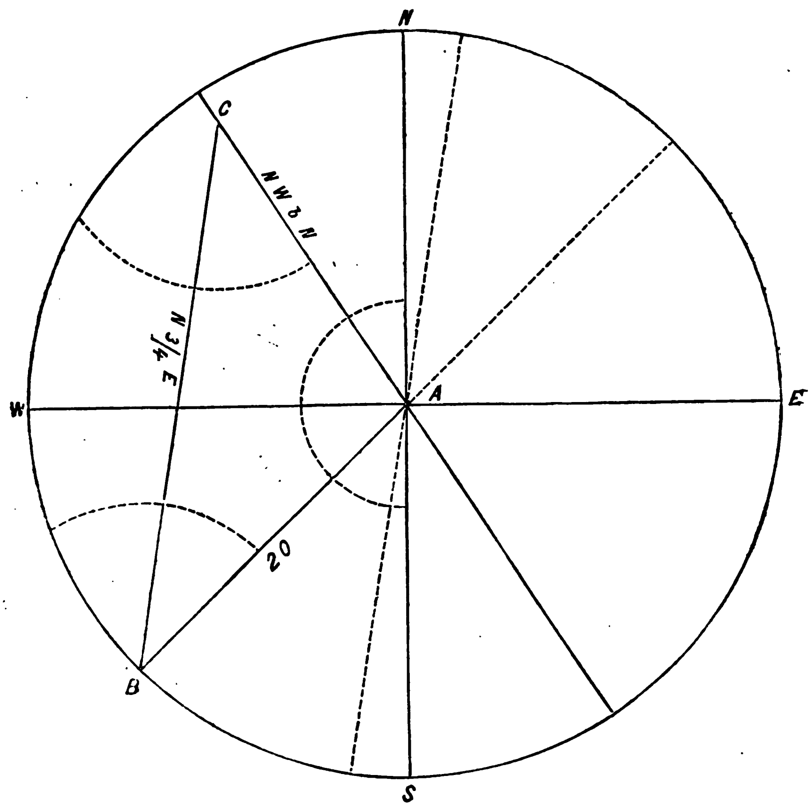


With the sine of 90° in the compasses, and one foot in P the pole, describe the equator E Q, and with the co-sine of the parallel 51°.25′ describe the parallel *p* L. Take the meridian distance or departure from any scale of equal parts, and lay it off on the last drawn parallel from M to D, through M and D, draw P*a* and P*e*, and it is done, for *a e* will measure the difference of longitude made = 1668 miles or 27°.48′, westing this added to 9°.22′ = longitude left gives 37°.17′ West longitude in.

PROBLEM 46.

A ship about to take her departure from the land. Set a point which bore by azimuth compass true N. W. by N., and after sailing S. W. 20 miles the same point bore by the same compass North ¾ E. Required the ship's distance from that point at both stations.

Solution by construction.



Describe the compass N S E W with the chord of 60°, and from the centre A, the ship's place, draw the first line of bearing indefinitely to meet the point of land, at an angle with the meridian N. S. equal to the bearing = N W. by N. or 3 points. Lay off also

from the meridian S. N. the ship's course S. B. = 4 points. Draw the ship's track A B., and make it equal to the distance sailed = 20′; join B C and it is done, for the intersection of B C with A C will be the place of the point of land. *Now to find the distance* A C :—

As angle C = 3¾ pts.	Ar. Co. Log sine	0.17292
Is to the side A B = 20 miles	Log	1.30103
So is angle B = 3½ pts.	Log sine	9.77503
To distance A C = 17.7 miles	...	1.24898

To find distance B C.

As angle C = 3¾ points	Ar. Co. Log sine	0.17292
Is to A B. = 20 miles	Log	1.30103
So is the angle A = 9 points	Log sine	9.97158
To distance A C = 29.2 miles	Log	1.44553

Hence the distance of the ship from the point of land at the first station was 17¾ miles, and at the second station 29¼ miles nearly.

PROBLEM 47.

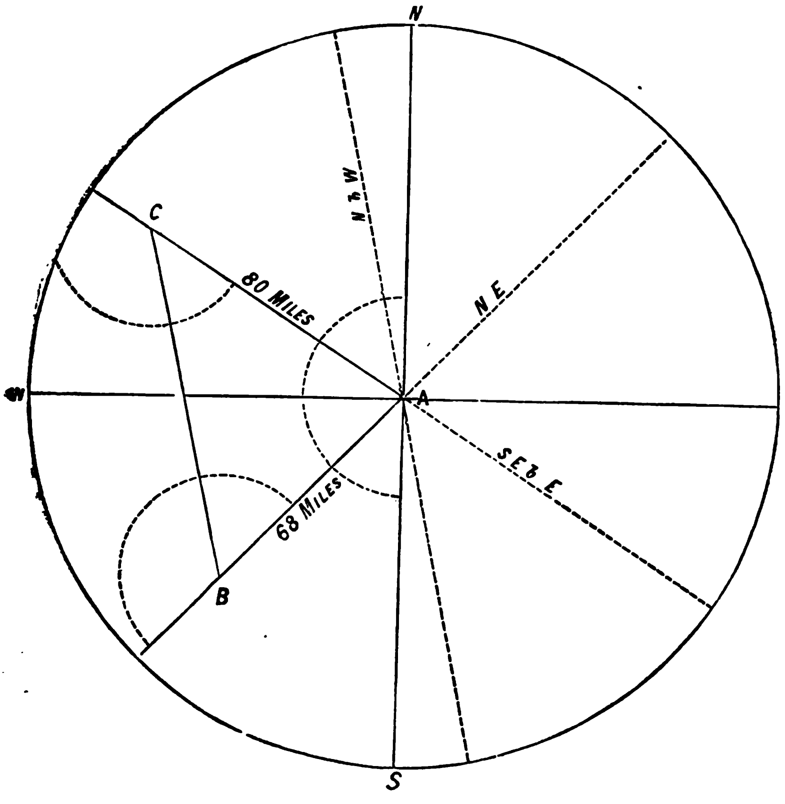
Two ships sail from the same port, one on a course of N. W. by W. for a distance of 80 miles; the other on a course of South West 68 miles. Required the bearing of those ships from each other and the distance between them.

Here we have an oblique angled plane triangle, in which two of the sides are given, and all the angles known, to find the side B C and the bearing of the two ships. And if we subtract the course = 4 points from the angle B we have the bearing of the ships, viz., 4 points = the course, subtracted from angle B = 5 points leaves 1 point, hence North 11°. 15′ West from B to C, and South 11°. 15′ East from C to B.

To find the side B C = Distance between the ships.

As the angle B = 56°. 15′	Ar. Co. Log sine	0.08015
Is to the side A C = 80 miles	Log	1.90309
So is the angle A = 7 points	Log sine	9.99157
To the distance B C	94.87 Log.	1.97481

Construction.



PROBLEM 48.

TO REGULATE A CHRONOMETER BY EQUAL ALTITUDES OF THE SUN.

On the 2nd day of March, 1865, the following equal altitudes of the sun's lower limb were observed by means of an artificial horizon, at a place in Latitude 39°. 15′. 08″ North, and Long. 76°. 36′. 6″ West. Previous to the observations in the forenoon the watch was compared with the chronometer, and the time shown by the former was 20h. 33m. 10sec., and by the latter 3 days 1h. 51m. 50sec. And in the afternoon, when the watch showed 3h. 26m. and 50sec., the chronometer indicated 8h. 45m. 30sec. Since the difference 5h. 18m. 40sec. is the same at both observations, it is a proof that the watch has gone uniformly during the interval.

From these elements it is required to find the *error* of the chronometer for mean time at Greenwich.

	Altitudes.	Morning Times from Noon March 2nd. H.	M.	S.		Evening Times from Noon March 3rd. H.	M.	S.
Double Angles Artificial Horizon.	81°.00′	20	32	12		27	27	48
	81°.10′	20	32	41		27	27	19
	81°.20′	20	33	10		27	26	50
	81°.30′	20	33	39		27	26	21
	81°.40′	20	34	08		27	25	52
	Mean	20	33	10	Mean	27	26	50
	Difference is elapsed time = 6h. 53m. 40s.					20	33	10
	Sum					2)48	00	00
	Middle Time					24	00	00

Constant Log.	8.8239	Constant Log.	8.8239
Latitude 39°.15′.8″ Co-T.	10.0875	⊙ Dec. 6°.36′.55″ Co-T.	10.9356
El. Time 6h. 53m. 40s. S.	9.8948	Tangent El. T.	10.1028
„ „ 6 53 40 P.L.	1.4180	P. L.	1.4180
Vari. of dec. 23′.04″ P.L.	0.8923	P. L.	0.8923
First part 13″.46‴ P.L.	1.1167	Second part 1″.13‴ P. L.	2.1726

	H.	M.	S.	TH.
Middle time	24	00	00	00
1st. part ... ... —			13	. 46
	23	59	46	14
2nd part ... ... —			1	. 13
Mean time by Chronometer	23	59	45	01
Middle time	24	00	00	00
Chronometer too slow for	00	00	14	59 M. T. at

G., March 3rd, at Noon.

Example 2nd.

Suppose that on the 9th day of May, 1865, in latitude 40°. North, and longitude 15°. West, the following observations at equal altitudes of the sun were taken. Required the error of the chronometer.

Alt. ⊙'s LL.	Times per chron. A. M. 8th May.	Times per chron. P. M. 9th May.
15 . 35	18 . 29 . 51	17 . 32 . 18
15 . 45	18 . 31 . 07	17 . 31 . 00
15 . 55	18 . 32 . 14	17 . 29 . 54
Mean ...	18 . 31 . 04	17 . 31 . 04

Difference is elapsed time = 11h. 00m. 00s. 18 . 31 . 04

Reject 12 hours ... ... = 36 . 2 . 8

2)24 . 2 . 8

Middle time ... ... 12 . 01 . 04

Constant log	8.8239	... ...	...	8.8239
Latitute 40°. Co-Tan.	0.0762	Dec. 17°.26′.47″	Co-Tan.	0.5026
El. time 11h. sine	9.9963	... ...	Tan.	0.8806
El. time 11h. P. L.	1.2139	... ...	P. L.	1.2139
Vari. of dec. 15′. 45″ P.L.	1.0575	... ...	P. L.	1.0575
P.L. 1st part 12″. 14‴	1.1678	2nd part 0″. 36‴	P. L.	2.4785

		H. M. S. T.
Middle time ...	... ...	12 . 01 . 04 . 00
1st part	... ... —	12 . 14
		12 . 00 . 51 . 46
2nd part	... ... +	. 36
Mean time by watch	... ...	12 . 00 . 52 . 22
Middle time, true ...	... ...	12 . 00 . 00 . 00
Watch too fast for app. time		52 . 22

PROBLEM 49.

LUNAR OBSERVATIONS.

On the 14th day of July, 1860, at 2h. 35m. 40s. P.M., true mean time, in latitude 36°. 17′ N. and longitude by account 76°. 36′ West

the *apparent* altitude of the sun's centre was found to be 51°.28'.46", and that of the moon's centre 28°.18'.57"; at the same time the apparent distance between their respective centres was 49°.22'.12". Required the longitude.

To find the true distance.

☽ 's Hor. Par.	00°.56'.56"	PL. 0.4999	Same	..	..	..	PL	0.4999
☉'s App. Alt.	51 28 46	Co-sec 0.1066	☽ 's App. Alt. 28°. 18'. 57"				Co-Sec.	0.3239
App. distance	49 22 12	Sine 9.8803	..	..	..		Tangent	0.0665
1st Correction	4 1 20	Log. 0.4868						
2nd Correction	5 23 11	.. ..	..	..	..	..	Log.	0.8903
3rd Correction	1 21							
— 10° ..	48 48 04							

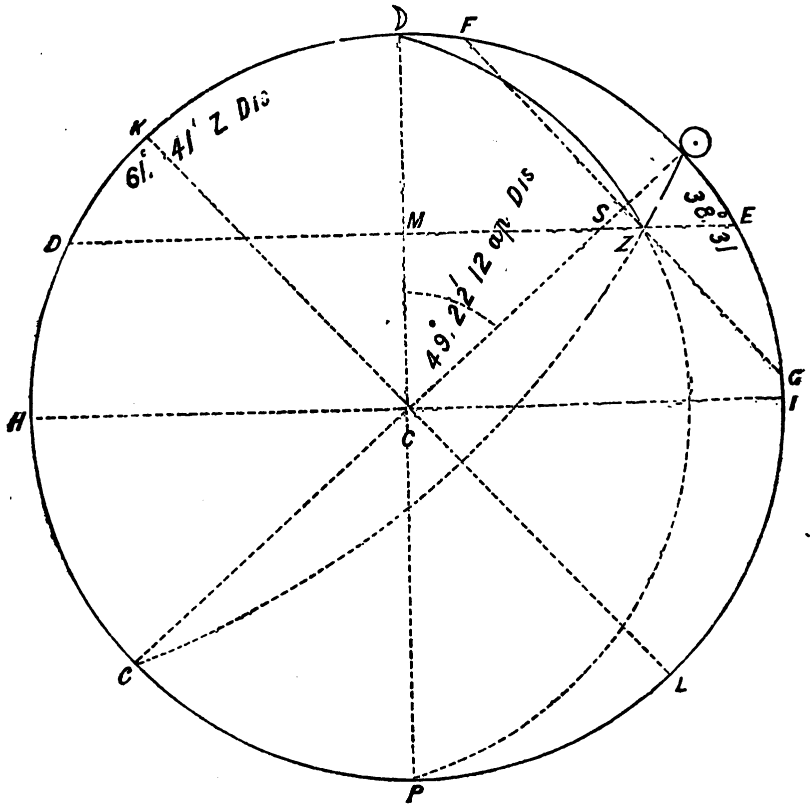
To find the Longitude.

True distance		48°.48'.04"		
Distance N.A.	Next greater at 6h.	49. 39. 43	P.L.	2958
		51. 39	P.L.	5422
		H. M. S.		
Time past 6h.	... ...	1. 42. 04		2464
Time over 1st dist. ...	... ...	6. 00. 00		
Mean time at Greenwich	... ...	7. 42. 04		
Mean time at Ship	... ...	2. 35. 40		
Longitude in time ...	... ...	5. 06. 24	= 76°.36' West.	

In the above example the altitudes and distance are *supposed*, and given corrected, in order to show the formula, but in practice the altitudes must when observed, be reduced to the *apparent* altitudes by applying the dip and semi-diameter

The observed distance of the limbs must also be increased by adding the sun's semi-diameter and the moon's augmented semi-diameter, in order to find the *apparent* distance between the centres of the objects.

Construction.



With the chord of 60°, describe the primative circle representing that great circle which passes through the sun and moon at the time of observation, make the angle ☽ C ☉ = to 49°.22'.12", the apparent distance. Draw the lunar and solar lines ☽ C and ☉ C, lay off the moon's zenith distance both ways to D and E : draw the line D M E cutting the Solar line in S, intersecting the line F G in Z. Make ☉ F and ☉ G = sun's zenith distance = 38°. 31' and draw F G. Then the co-sine M Z is the lunar line of correction, and the co-sine S Z, the solar line of correction. Take the extent M Z in the compasses, and apply it to the line of chords (in which the degrees and minutes are to be esteemed as minutes and seconds), and the measure of the lunar line of correction will be obtained, which is *subtractive,* because it falls to the right of the vertical lunar line ☽ C P, but *additive* when

it falls to the *left*. In the same manner take S Z in the compasses, and apply it to the line of chords, and it will give the solar line of correction. Now, having found the lunar and solar (or stellar) lines of correction, and the radius C ☉, C ☽, being esteemed as = to 1 degree, the true correction will be obtained by the following proportions.

As 1°. = 60′ is to the lunar line of correction, so is the moon's horizontal parallax to the effects of that parallax on the apparent distance, and so is the moon's refraction to its effects on the distance also.

Again.—As 60′ is to the solar line of correction, so is the sun's refraction to the effects of that refraction on the apparent distance, and so is the sun's horizontal parallax to its effects on the distance also.

Example 2nd.

On the 15th day of July, 1865, at 1h. 20m., P.M., true mean time at ship in latitude 41°. 42′ N., and longitude by account, 41°. 47′ W., the *apparent* altitude of the sun's centre was 68°. 40′., and that of the moon's centre 46°. 37′, and at the same moment the *apparent* distance between their respective centres was 89°. 57′. Having a chronometer on board, the time by it was noted and found to be 4h. 07m. 08sec., true mean Greenwich time. Required the longitude by the lunar and by the chronometer.

To find the true distance.

☽'s cor. hor. par.	00°59′.15″	P.L. 0.4826	Same P.L.	0.4826
☉'s app. alt.	68 .40 .00	Co-s. 0.0476	☽'s app. alt. 46.37. Co-s.	0.1386
App. dist.	89 .57. 00	Sine 0.0000	Tangent	12.0591
1st correction	4. 6 .54	Log. 0.5302	2nd Cor. 5°.0′.23″ =	2.6803
2nd correction	5. 0 .23			
— 10°	89 .04 .17			
3rd cor.	31			
True dis.—10°	89 .04 .48			

To find the Longitude.

True distance	89°. 04′. 48″	
Dist. N.A. at 4h.	89. 8. 44	P. L. 2616
	3. 56	P. L. 1.6605
Of Time Post 4h. = 00h. 07m. 11s.		P. L. 1.3989

	H. M. S.
Of time past 4h.	00. 7.11
Time N.A.	4. 0.00
Mean time at Greenwich	4. 7.11
Mean time at Ship	1.20.00
Longitude in time	2.47.11 = 41°.47′.45″ West.

Differing three seconds from the actual time as shown by the Chronometer, therefore, we may presume that the Chronometer is correct.

PROBLEM 49.—Example 1.

Great Circle Sailing.

To find the Great Circle Course from one place to another, both being on the same side of the equator.

The following formula is the best:—

Rule.—Required the course from a point in latitude 40°. N, and longitude 70°. West, to a place in latitude 50° North, and 10°. West.

Half sum of lats. = 45°. Half diff. lats. = 5°. Half diff. long. = 30°.

½ diff. lat. = 5°.	co-sine.	9.99834	½ diff. lat. = 5°.	sine.	8.94030
½ diff. long. = 30 .	co-tang.	10.23856	same	co-tang.	10.23856
½ sum lat. = 45 .	co-sec.	10.15051	½ sum of lats. 45°.	secant.	10.15051
½ sum courses 67°.43′	Tang.	10.38741.			
12°.03′	...	...	½ diff. courses	Tang.	9.32937

Course N. 79°.46′ W. from lat. 50°. N.

Course N. 55°.40′ E. from lat. 40°. N.

By Mercator's sailing, the course from 50°. North in S. 76°.42′ W. = a difference of 23°.32′.

When the two places are in the same parallel of latitude the sum of the logarithms in Col. 1 will be the log-tangent of the course from either place towards the other.

Example 2.

Required the Great Circle Course from a place in 40°. South and longitude 20°. East, to another place in 40°. South and 80°. East.

½ diff. of latitudes	0°.	Co-sine	10.00000
½ diff. of longitudes	30°.	Co-tang.	10.23856
½ sum of latitudes	40°.	Co-sec.	10.19193
Angle of position or course	69°.38′.	Tang.	10.43049

Here, too, is a difference, as compared with Mercator's course, of 20°.22′.

To find the distance.

Diff. longitude	60°.00′	Sine	9.93753
Latitude	40 .00	Co-sine	9.88425
Course	69 .38	Co-sec.	10.02804
Distance	45 .03	Sine	9.84982
	60 .		
	2703	Great circle distance.	
	2758	Parallel sailing distance.	
Distance	55 miles saved by great circle sailing.		

Example 3.

Given the latitudes and longitudes of two plans, as in example 1, case 1, viz., 40° North and 70° W., and 50° North and 10° West. Required the maximum latitude. The Great Circle courses are found to be by case 1, N. 55°. 40′ E., and N. 79°. 46′. W.

To find the maximum latitude.

Latitude 40°.	... ...	Co-sine 9.88425
Course 55 . 40	... ...	sine 9.91686
Of max. lat. 50°. 45′.30″.	... ...	Co-sine 9.80111

To find the longitude of the maximum latitude.

Latitude 40°	... ...	sine 9.80807
Course 55 . 40	... ...	tang 10.16558
Diff. of longitude 46°. 44′		Co-tang 9.97365
Long. left 70 . 00		
23 . 16 Longitude of maximum latitude.		

Let the latitudes and longitudes of the places be as in example 1, case 1, and the courses as therein found 55°. 40′, and 79°. 46′. Required the distance.

Diff. Long.	60°. 00′	Sine	9.93753
Greatest lat.	50 . 00	Co-sine	9.80807
Least course	55 . 40	Co-sec.	10.08314
Distance	42 . 23 ...	Sine	9.82874
	60		
	2543 miles		

Another method.

RULE.—Add together the log secant of half the difference of the two courses, the log co-sine of half the sum of the two courses; and the log co-tangent of half the sum of the latitudes; the sum, rejecting 20 in the index, will be the log tangent of half the distance.

Example.

Given the ports, as in the previous example. Required the distance.

½ diff. courses	= 12°. 03′	Secant	10.00968
½ sum „	67 . 43	Co-sine	9.57885
½ sum latitudes	45 . 00		10.00000
	21°. 11½′	Tangent	9.58853
	2		
	42°. 23′ = 2543 miles.		

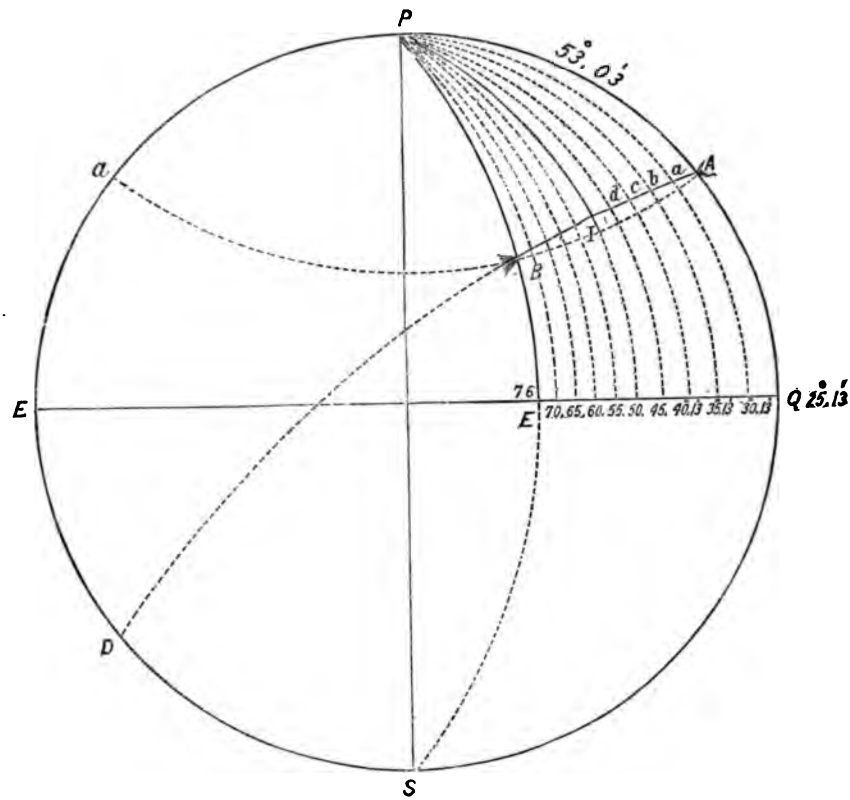
Distance by Mercator's sailing 2608 miles; gain on the Great Circle 65 miles.

General application of Great Circle Sailing.

A ship from the Island of St. Mary's, one of the Azores, bound to Baltimore, up the Chesapeake Bay, purposes to sail, as near as possible, on the arc of a great circle, by altering her course at every 5° of longitude. Required the latitude at each time of altering the course, and the distance sailed; and also the course and distance between St. Mary's and Cape Henry, (at the entrance of the Chesapeake Bay,) by Mercator's sailing, and the difference.

Describe a circle representing the meridian of one of the places proposed, say the eastern one, at St. Mary's; draw the line E Q, representing the equator; at right angles to this, draw the axis P S, whose extremity P, represents the north pole. On the primitive

Construction.



circle lay off from P towards Q the co-latitude of St. Mary's at A, and describe the parallel of latitude *a* A; with the tangent of the difference of longitude = 50°.44'.2", describe the meridian of Cape Henry, P B S, the intersection of which with the parallel *a* A, will show the place of Cape Henry. Through the points A B describe a great circle A B D. Then A represents St. Mary's, and B Cape Henry. P A and P B are the co-latitudes, the angle A P B, which is measured by the arc Q E, is the difference of longitude. The arc A B is the nearest distance between those places. The angle P A B is the angle of position from A to B. The places having the same latitude P A and P B are equal, and the angle P A B is equal to the angle P B A. Therefore if the arc P I be described, making the

angle A P I equal to 25°.22′ = the half of the difference of longitude, then will P I be perpendicular to A B, bisecting it, and in the triangle A P I right angled at I, there will be given the hypothenuse=53°. 03′, the angle A P I=25.22′ to find the leg A I=half the distance sought, and the angle P A I equal to the angle of position.

To find the distance A I *and* A B.

As radius 90°		Ar.Co.log 0.00000
Is to hypothenuse, Co-lat.	53°.03′	Log sine 9.90263
So is ½ diff. long. ...	25 .22	Log sine 9.63186
To A I = ½ distance	20°.01¼′	Log sine 9.53449

which being doubled gives 40°.02½ = 2402½ miles, which is 28.5 miles less than 2431 the distance by parallel sailing, for as R : 50°.44′ = diff. long. : : co-sine 37° = latitude : 2431.

To find the angle of position at A.

As radius	90°.00′	Ar. Co. log.	0.00000
Is to latitude	37 .00	Log sine	9.77946
So is ½ diff. longitude	25 .22	Log Tangent	9.67589
To angle of position at A	74°.05′	Log co-tang.	9.45535

Now the triangle A P B being isosceles, the perpendicular P I is in the middle of A B; and the latitude, course, and distance being known in running the half A I, those in the other half, I B, will also be known (see figure). Let the points *a, b, c, d,* &c., each 5° of longitude from the other, be the places come to at each alteration of the course. Then will the arcs P *a;* P *b;* P *c;* P *d,* &c., be the respective co-latitudes of those places, and are the hypothenuses of the triangles I P *a;* I P *b;* I P *c;* I P *d,* &c.

To find the highest Northern latitude.

As radius	90°. 00′	Ar. co. log.	0.00000
Is to Co-lat. P B	= 53 . 03	Log sine	9.90263
So is angle B =	74 . 05	Log sine	9.98302
To comp. P I highest N. lat.	39°. 50′	Log sine	9.88565

Now angle IPA = $\frac{50°.44'}{2}$ = 25°.22′ — 5°. = 20°. 22′—5°.=15°. 22′—5°.=10°. 22′—5°. = 5°. 22′. are the several polar angles.

To find the several latitudes.

	P L 20°.22′	P L 15°.22′	P L 10°.22′	P L 5°.22′	P L 0°.22′
As Radius 90°...	10.00000	10.00000	10.00000	10.00000	10.00000
Is to P I = 50° 10′ co-tangent.	9.92125	9.92125	9.92125	9.92125	9.92125
So is Polar angle, co-sine ..	9.97196	9.98419	9.99285	9.99809	9.99999
To the several latitudes, Tan..	9.89321	9.90544	9.91410	9.91934	9.92124
Which are the latitudes ..	38°01′30″	38°48′40″	39°21′15″	39°42′35″	39 . 50
	a	*b*	*c*	*d*	I

Thus, having arrived at the highest North latitude, and the courses and distances in the first half of the arc A B being known, then those in the other half are also known. The degrees and minutes set over each column are the polar angles, the co-sines of which are used in the proportions, and the corresponding latitudes stand at the bottom. The first term of these proportions being radius (might in practice be rejected), and the second time being common to all the columns, the operation may be performed very expeditiously as above. Now from the several positions, find the courses and distances by Mercator's sailing; and, if the result of the several operations be arranged in a table in the following manner, it will be found very convenient.

Angles.	Polar Angles.	D.Longs.	Suc.Lats.	Diff. Lon.	M.Parts.	M. Diff. Lat.	P. Diff. Lat.	Course.	Distance.
IP A	25°. 22′	25°.22′	37°.00′	Miles	2393	Miles.	Miles.	True.	
IP a	20 . 22	30 . 22	38 . 01	300	2470	77	61	N. 75°.36′ W.	245 . 3
IP b	15 . 22	35 . 22	38 . 49	300	2531	61	48	„ 78 30 „	240 . 7
IP c	10 . 22	40 . 22	39 . 21	300	2572	41	32	„ 82 13 „	236 . 3
IP d	5 . 22	45 . 22	39 . 43	300	2601	29	22	„ 84 29 „	228 . 7
to I		50 . 38	39 . 50	322	2610	9	7	„ 88 24 „	250 . 7
								Half the distance in miles	1201 . 7

The first column contains the angles at the Pole contained between the perpendicular PI, and the several meridians, differing by 5°. of longitude: the second column contains departed longitudes: in the third are the successive latitudes passed through from St. Mary's to the highest Northern latitude required: in the fourth column is the difference of longitude: in the fifth, the meridional parts: in the sixth, the meridional difference of latitude: in the seventh, the proper difference of latitude between the several points: in the eighth, the courses from each point to the next, and in the ninth, the distances to be sailed on each course. Now these distances being summed up, amount to 1201.7 miles, which being doubled gives 2403.4 miles for the whole

distance, differing from the true spherical distance only .9 tenths of a mile: and the courses a ship must steer are, 1st N. 75°.36′ W.; 2nd N. 78°.30′ W.; 3rd N. 82°.13′ W.; 4th N. 84°.29′ W.; 5th N. 88°.24′ W.; 6th S. 88°.24′ W.; 7th S. 84°.29′ W.; 8th S. 82°.13′ W.; 9th S. 78°.30′ W.; 10th S. 75°.36′ W., and having run on these courses, *true*, the distances standing against them, she will have arrived within four miles of Cape Henry.

PRACTICAL REMARKS.

It will be seen by the foregoing that Great Circle Sailing is as simple as any other method of navigation. But in sailing ships with the variable winds which prevail in high latitudes it is rarely available. In steamers, in some instances, a few hours may be saved, but the advantage to be gained is in general too small to warrant the least risk in pursuing the Great Circle. Near the Equator the advantage is so trifling as to be wholly unworthy of notice, and off the Capes the Great Circle leads vessels into storms, and often among icebergs, which are not found on the track given by Parallel Sailing. A compromise, however, between the Great Circle and Parallel Sailing, may be made with advantage in the passage round the Cape of Good Hope, if bound to New Zealand or Australia, as ships are likely to have stronger winds to the Southward of the 40th parallel, than further North. But to shape a course with a view of passing to the Southward of Prince Edward's Island, the Crosets or Kerguelen's-land is certainly not advisable; which a ship must do if she would adhere to the Great Circle. Experience, which is the best teacher, has proved that in passing Cape Horn, *both ways*, the nearer the ship is kept to the land the shorter will be the passage, and the less will be the "wear and tear," both of sails and the crew. Ships wishing to make a good passage round the Horn, should make the land at, or to the North of Cape Virgin's, and pass by *all means* through the straits of Le Maire, hugging the land all the way round until the Pacific is open. Work to the Westward in the parallel of the Cape, or *steer* to the Westward when possible, regardless of Northing, until in longitude 84°. W., then run N., true, until within (to the North of) the 45th Parallel. There is no danger near the land, if the ship is kept *clear* of *the Kelp*, and there is good anchorage under Hermit Island, in the Bay of Good Success, and under Cape San Diego, where vessels may wait for favourable winds, rather than stand to the Southward. The writer has made thirteen voyages to the "West Coast," and has never been outside of Diego Ramirez! Has never lost a sail or spar, nor

seen an iceberg in the vicinity of Cape Horn. The straits of Magellan is not advisable, except for a smart ship, a determined commander, and a *willing, contented* and manly crew, all of which it is not usual to find in one vessel now-a-day. To pursue the Great Circle in rounding Cape Horn to the Westward, would be simply preposterous, though a a compromise between it and Parallel Sailing may be made with advantage, by vessels bound from New Zealand or Australia to this country.

GAUGING.

Reduction of Measures.

RULE.—Multiply the old standard gallons by the constant logarithm, 9.920703, and the product will be the new standard gallons.

Example 1.

Reduce 180 old standard wine gallons to the new standard measure.

Old standard gallons 180	Log.	2.255273
Constant Log.		9.920703
New standard gallons 149.96	Log.	2.175976

Example 2.

To reduce New Imperial Measure to Old Standard Wine Measure.

RULE.—Multiply the new standard gallons by the constant logarithm, 0.079297, and the product will be the old standard gallons.

New standard 149.96 gallons	Log.	2.175976
Constant log.		0.079297
Old standard gallons 180		2.255273

One-fifth is *nearly* the difference between the old and new standard wine gallon.

To reduce the New Imperial Measure into the Old Standard Ale Measure.

RULE.—Multiply the New Standard Gallons by the constant logarithm 9.992660 and the product will be the Old Standard Ale Gallons.

Example 3.

Reduce 500 gallons of the New Imperial Gallons to the Old Standard Ale Gallons.

New imperial gallons, 500	Log.	2.698970
Constant log.		9.992660
Old standard ale gallon 491.62 ...	Log.	2.691630

(Or nearly one-sixth difference.)

To reduce the old standard ale measure into the new imperial measure.

RULE.—Multiply the old standard ale measure into the constant logarithm 0.007340, and the product will be the new general standard measure.

Example 4.

Old standard ale gallons, 491.62	Log.	2.691620
Constant log		0.007340
New imperial gallons, 500	Log.	2.698960

Having the dimensions of a cask, to find its content.

Let the bung diameter be 27-inches; head diameter 21.5, and the length 36. Required the content in ale, wine, and new imperial measure $21.50 \div 27 = 0.79$. Quotient of hd. ÷ by bung diameter

Quotient 0.79	Log. for ale gallon	7.366479
Bung diameter = 27 corresponding log. ...		2.862728
		10.229207
Length of cask, 36-inches common log. ...		1.556303
Content in ale gallons, 61.02	Log.	1.785510
Constant log.		0.007340
Content in imperial gallon, 62.066 ...	Log.	1.792850

FOR WINE GALLONS.

Quotient 0.79 ...	Log. for wine gallons	7.453120
Bung diameter, 27-inches	Log.	2.862728
Length of cask, 36-inches	Log.	1.556303
Content in wine gallons, 74.49 ...	Log.	1.872151

TO FIND THE ULLAGE, OR QUANTITY OF LIQUOR IN A CASK THAT IS NOT FULL.

RULE—Suppose the cask to stand on end, and its length to be represented by unity or 1.0000, half of this will be .5000 which is a constant. Now measure the depth of the liquor, *or wet* inches, and divide these inches by the length of the cask to four places of decimals find the difference between this quotient and constant .5000; if this last found difference be less than .5000 substract one-tenth part of it from the quotient, but if the difference be more than .5000 add one-tenth of the difference to the quotient, and the sum or difference will be the *multiplier*.

Now multiply the *multiplier* by the contents of the cask in wine measure, and the product will be the ullage or number of wine gallons in the cask, and this can be reduced to imperial measure by using the constant logarithan 9.920703, and if the content of the cask be given for ale measure, the constant log. to reduce this to imperial measure will be 0.007840.

Example.

Let the cask's length be 36 inches, its content in wine gallons 74.49, and the depth of the ullage, or wet inches 18.5. Required the quantity of liquor in the cask? Depth of ullage, or wet inches 18.5÷36

Inches (length)	0.5139	quotient .5139	
Constant	0.5000		
	139 ÷ 10	... subtract 14	
Multiplier		.5125	Log. 9.709694
Content of cask in wine gallons, 74.49			Log. 1.872098
Ullage or quantity of liquor in wine gallons 38.11			Log. 1.581792
Constant			Log. 9.920703
Ullage or quantity in cask imperial gallons 31.80			Log. 1.502495

Almost all officers of vessels are accustomed to square, or cubic measure. As a ready approximation, if the cubic contents of a tank be computed, and the number of cubic feet be ascertained, by multiplying this by 6.24, the number of imperial gallons it will hold will be obtained.

Each imperial gallon must weigh 10lbs. avoirdupoise of distilled water; each lb. of which contains 7000 grains (troy). A cubic inch of distilled water weighs 252.458 grains (troy), therefore by proposition we have the contents of a standard gallon, for as 252.485 grs. : 1 inch : : 70.000 : 277.27384357 inches, which is the number of cubic inches in a standard gallon. And as 277.27384357 will go into 1728, the number of cubic inches in a cubic foot, 6¼ times nearly, we have the above *rule*, which is sufficiently near the truth for practical purposes in ascertaining the amount of water stores required, or on hand at any time. If greater accuracy be required in case of valuable liquors, &c., the rules laid down should be worked out in full.

The question may be asked what are these *Constant Logarithms?* *Ans.* 277.27384357 = number of cubic inches in an imperial gallon divided by 231, the number of cubic inches in the old standard wine gallon gives 1.20031967, the log of which is = 0.079297. And this is the multiplier for reducing the *new* to the *old* standard measure. Again, 231 = the number of cubic inches in the old standard wine gallon divided by 277.27384357 = 0.83311140, the log of which is 9.920703, and this is the multiplier for reducing the *new* into the *old* standard measure. Thirdly. 277.27384357 = the number of cubic inches in a new standard gallon, divided by 282 = the number of cubic inches in the old standard ale gallon, gives 0.98324055, the log of which is 0.007340 and this is the multiplier for reducing the *old* standard ale, into new standard measure.

Explanations and Definitions.

The Celestial Poles are two immoveable points round which the heavens seem to move from East to West, and may be termed the extremities of the earth's axis, produced to the apparently concave surface of the starry heavens.

The apparent motion of the heavens, from East to West, is caused by the *diurnal motion* of the earth on its axis from West to East, hence the *allusive* motion in a contrary direction given to the heavenly bodies.

The first meridian is that meridian which passes through the Royal Observatory at Greenwich, as far as England, and nearly all works on navigation are concerned, but it is perfectly arbitrary. The Americans call the meridian passing through Washington, their capital, the first meridian. The Spaniards call the first meridian that which passes through Cadiz.

The Zodiac is a belt extending about 9°. on each side of the Ecliptic, and embracing the orbits of all the planets known to the ancients. In the centre of this belt is the sun's apparent path, called the Ecliptic. *The Ecliptic* is divided, like all other great circles, into 360°., and also into twelve equal signs, called and known by the following names and signs:—

1	♈	Aries	7	♎	Libra
2	♉	Tauras	8	♏	Scorpio
3	♊	Gemini	9	♐	Sagittarius
4	♋	Cancer	10	♑	Capricornus
5	♌	Leo	11	♒	Aquarius
6	♍	Virgo	12	♓	Pisces

The first six signs are called *Northern* signs, and the others *Southern* signs, because from the *first* point of Aries to the last point of Virgo the sun has *North* declination, while from the first point of Libra to the first of Aries he has *South* declination.

The equinoctial points, are the first points of Aries and Libra. When the sun arrives at these points he is on the equinoctial, and has no declination.

The Solstitial points are at the intersection of the solstitial colures with the ecliptic, and 90 degrees from the first points of Aries and Libra. When the sun arrives at these points he attains his greatest declination, when at the summer *solstice* he is in the sign of Cancer, his declination is then 23°. 27′. 27″ North. When at the *winter solstice* he is in the sign of Capricornus, his declination is then 23°. 27′. 27″ South.

The Tropics are two small circles parallel to the equinoctial passing through the solstitial points, and consequently are 23°. 27′. 27″ North and South of the equinoctial.

The Polar Circles are two small circles parallel to the eqinoctial 66°. 32′. 23″ from it, North and South. These circles separate the *frozen* from the *temperate Zones,* as the *Tropics* separate the temperate from the *torrid Zones.*

The Culminating Points are those points at which a heavenly body has its greatest altitude, or where it comes to the meridian.

The transit and meridian passage are synonimous terms.

The Geocentric Latitude, Longitude, right ascension and declination of a heavenly body, are those, as seen from the centre of the earth.

The Aphelion of an object is the point most distant from the sun.

The Perihelion is that point of the orbit of the earth or other object which is nearest to the sun. This is called the *lower apsis,* while the Aphelion is called the *upper apsis.*

The line of the Apsides is a straight line joining the centres of the sun and earth, or other planet.

The Radius Vector is the true line of distance between the centres of the earth and sun.

Equation of time.

The question is often asked by young navigators, "what is the equation of time?" "Why is it sometimes additive to, and sometimes subtractive from apparent time?" or "Why is such a correction necessary at all?" We shall endeavour to answer these questions thus: Time, which of itself flows uniformly, has its parts measured

by the apparent motion of some heavenly body, or visible object; and the sun being the most conspicuous object, and appearing to move with the greatest uniformity, his motion has been chosen as the most proper measure of the parts of time, as well for the days as for the years. Hence the astronomical day, at any place, *begins* when the sun's centre is on the meridian of that place; and is divided into twenty-four hours, reckoned in numerical succession from one to twenty-four. The first twelve hours are sometimes distinguished by the mark P.M., signifying *post meridian*, or afternoon; and the latter twelve are marked A.M., signifying *ante meridian*, or before noon. But these marks, though convenient and necessary to the division of time on land, are useless to the navigator in his nautical calculations. In short, the "civil" and "nautical" divisions of time should be ignored altogether, as all the calculations and elements required in navigation must be accounted and corrected for "*astronomical time*." Thus, what would be July the 10th at 5 o'clock in the morning is really July the 9th at seventeen hours. It is necessary that young navigators should have a clear understanding on this point.

The sun's daily motion in *longitude*, is the arc of the ecliptic run through in that day; and his daily motion in *right ascension* is the corresponding arc of the celestial equator, or equinoctial; and the "*mean* daily motion," in either circle, is measured by 59'.08" nearly; for as 365 days : 1 day : : 360° : 59'. 08". *An astronomical or solar day*, is the interval of time between the successive transits of the sun's centre over the same meridian, and is measured by the sum of the whole equinoctial, and an arc thereof, equal to the daily motion in right ascension. For at the end of the diurnal rotation, which by observation is known to be uniform, the meridian is returned to the same star, or point of the ecliptic, at which it was at the preceding noon; but the sun, during this revolution, has removed from that star or point to another, which has a greater right ascension; therefore, before the meridian opposite to the sun can be gained, so much more of another rotation must be described, as is equal to the daily motion in right ascension.

A *sidereal* day is the interval between two successive returns of the same meridian to the same fixed star. This day is less than a solar day, and is measured by 360°. But a *mean* or equatorial day, is the elapsed time between two successive transits of the sun over the meridian of any place, and is measured by 360°.59'.08" nearly.

Mean, or equal time, is shown by a well regulated CLOCK, whose twenty-four hours measure the time the sun takes to describe an

equatorial arc of 360°.59'.08" nearly. The difference, therefore, between the measure of the mean solar day and a sidereal day, viz.: 59'.08", reduced to time, gives three minutes and fifty-six seconds, which shows that a star which was on the meridian with the sun on one noon, will return to that meridian 3'.56" before the next noon, as measured by the sun. Therefore a clock which measures MEAN or equal days will show 23h. 56m. 04s. for the length of the sidereal day. Apparent or true time is that shown by the sun-dial whose day is twenty-four hours, as measured by the sum of 360°, and that day's motion in right ascension. The solar days are unequal to each other, for observations show that the sun's daily motion in right ascension is continually varying. The true and mean solar days are never equal, except when the sun's daily motion in right ascension is 59'.08" which happens about February 11th, May 14th, July 26th, and November 1st; at all other times the length of the TRUE and MEAN days differ. The accumulation of these differences produces the EQUATION OF TIME; and sometimes the apparent noon will precede the time of the mean noon, and sometimes fall after it; their difference amounting to 16'.16" at the beginning of November. Hence the equation of time is the difference between the times shown by a clock and a sun-dial, or between the *mean* and *true* noons, or between the sun's right ascension and his mean motion taken on the equinoctial.

The difference arises on two accounts. First—Because of the *obliquity* of the *ecliptic*; the daily motion of the sun in longitude and right ascension are unequal. Secondly—Because of the unequal motion of the earth in an eliptic orbit. In the first and third quadrants, or between Aries, Cancer, Libra, and Capricorn, the right ascension being less than the longitude, or the mean motion taken on the equinoctial, the point of right ascension is to the west, and therefore the *apparent noon* precedes, or comes in consequentia to the meridian before the mean noon. But in the second and fourth quadrants, or between the signs of Cancer, Libra, Capricorn, and Aries, the right ascension being greater than the longitude or mean motion taken on the equinoctial, the *mean* noon is westward, and therefore it preceeds or comes in consequentia to the meridian before the apparent noon. From the aphelion to the perihelion, or in the first six signs to *anomaly*, the mean noon preceeds the apparent, and in the last six signs of anomaly, the apparent noon preceeds the true; their *difference* in either case, is the equation of the centre, which convert into time. Now, because the point of Aries and that of the sun's apogee, the places where the two parts of the EQUATION OF TIME commence,

continually recede from each other; therefore the whole equation of time made up of these two parts will serve only for a few years, and requires to be corrected from time to time.

To calculate the equation, or difference between the apparent and mean noons for any day proposed, find the mean and true anomalies for that time; their difference, or the equation of the centre, is one part. The true anomaly gives the sun's longitude, with which, and the obliquity of the ecliptic, compute the right ascension. The difference between the longitude and right ascension gives the other part. The sum, or difference of the two parts, turned into time gives the *equation of time sought.*

Note.—In studying the definitions with a view to investigate the principles of astronomical constructions, it is absolutely necessary that the student should either have a globe before him or a black-board on which the spheres can be drawn. In no other way can the mind so readily grasp the truths set forth in the several definitions. To attempt to study nautical astronomy without a globe or diagrams is simply absurd, and useless waste of time and money. Hence an hour's lecture with illustrations on a black board, by a man conversant with his subject, will convey more information than could be gained at schools, where books alone are used, in twelve months.

BUSINESS FORMS.

FORM OF SURVEY ON SHIP AND FURNITURE.

It often happens that ship masters are called upon, in foreign ports, to survey ships that have received damage by collision, stranding, stress of weather, or otherwise. We give the following form for the guidance of those who may for the first time be called upon to perform such duty:—

We, A. B. and C. D., shipmasters, and E. F., shipwright, residents of . . . . do hereby jointly and severally declare and attest, to all whom it may concern, that on the . . day of . . . . at the instance and request of G. H., master of the ship . . . of . . . . of the burthen of . . tons or thereabouts, proceeded to, and on board the said ship, to examine her hull, masts, yards, anchors, cables, rigging, running gear and sails, and every other store to her belonging, and having carefully and particularly inspected, examined, and surveyed the same, do report that the said vessel's hull, masts, yards, &c. *(as the case may be; here must be particularly set forth all*

defects, and their causes, as nearly as can be ascertained, particularly noting those that arise from rot or natural decay.) Taking into consideration the aforesaid state of the said ship, and the necessity of restoring her to a good and seaworthy condition; we hereby recommend that she be supplied with *(here must be enumerated in detail every necessary, as the underwriters are not liable for any article supplied or replaced without the recommendation of the surveyors.)*

Witness our hands this . . day of . . . in the year of our Lord 18 . .

A. B. Ship Master.
C. D. „ „
E. F. Shipwright.

If the ship masters are in command the names of their ships should be given, as future reference might be made to them.

☞ The Consul's certificate that the parties are known to him, and that the signatures are genuine, will prevent unnecessary litigation.

THE CALCULATION OF LOGARITHMS.

The student must ever bear in mind that multiplication by logarithms is performed by the addition of the logarithms of the two terms, and division is performed by subtracting these logarithms from each other. But the question is often asked, from whence come these "mysterious numbers." In order to answer this very proper question the following examples for forming lagarithmic tables are given.

TO FIND THE LOGARITHMS OF PRIME NUMBERS.

RULE.—Let the *sum* of the number whose lagarithm is sought and the next *less* number be called A:—

2nd. Divide 0.868588963* by A, reserve the quotient.

3rd. Divide the reserved quotient by the square of A, and reserve this quotient.

4th. Divide the last reserved quotient by the square of A, reserving the quotient, and thus proceed as long as division can be made.

* The number 0.868588963 is the quotient of 2, divided by 2.302585093 which is the logarithm of 10, according to the Lord Napier's first form. The manner by which this log of 10 is found may be seen in any good work on Algebra, but it is here purposely omitted, because this practical work does not contain the elements of Algebraic science, and because it is considered that those for whose use this work is intended had better *take for granted* the truth of *one number*, and thereby be enabled to *try the accuracy* of *any table* of *logarithms*, than to be compelled to receive such tables as accurately computed, without any means of examining the certainty thereof.

5th. Write the several quotients, orderly under each other, the first being uppermost.

6th. Divide the quotients respectively by the odd numbers 1 3 5 7 9 11 &c., that is, divide the first reserved quotient by 1, the second by 3, the third by 5, the fourth by 7, &c. Let these quotients be wrote orderly under each other, add them together and the sum will be a logarithm.

7th. To the logarithm just found add the logarithm of the *next less* number, and the sum will be the logarithm of the number sought.

Example 1.

Required the logarithm of the number 2.

Here the next less number is 1, and $1+2=3=A$, and the square of $A=3\times 3=9$. Then:—

$$\frac{0.868588963}{3} = .289529654 \text{ and } \frac{.289529654}{1} = .289529654$$

$$\frac{0.289529654}{9} = .032169962 \text{ and } \frac{.032169962}{3} = .010723321$$

$$\frac{0.032169962}{9} = .003574440 \text{ and } \frac{.003574440}{5} = .000714888$$

$$\frac{0.003574440}{9} = .000397160 \text{ and } \frac{.000397160}{7} = .000056737$$

$$\frac{0.000397160}{9} = .000044129 \text{ and } \frac{.000044129}{9} = .000004903$$

$$\frac{0.000044129}{9} = .000004903 \text{ and } \frac{.000004903}{11} = .000000445$$

$$\frac{0.000004903}{9} = .000000545 \text{ and } \frac{.000000545}{13} = .000000042$$

$$\frac{0.000000545}{9} = .000000060 \text{ and } \frac{.000000060}{15} = .000000004$$

To this logarithm 0.301029994

Add the log. of 1 ... ... = 0.00000000

Their sum is the logarithm of 2 ... = 0.301029994

A glance at the *rule* will show the simplicity of this operation.

Example 2.

Required the logarithm of the number 3.

Here the next *less* number is 2; and 3+2=5=A, the square of which is 25. Then:—

$$\frac{0.868588963}{5} = .173717792 \text{ and } \frac{.173717792}{1} = .173717792$$

$$\frac{0.173717792}{25} = .006948712 \text{ and } \frac{.006948712}{3} = .002316237$$

$$\frac{0.006948712}{25} = .000277948 \text{ and } \frac{.000277948}{5} = .000055590$$

$$\frac{0.000277948}{25} = .000011118 \text{ and } \frac{.000011118}{7} = .000001588$$

$$\frac{0.000011118}{25} = .000000445 \text{ and } \frac{.000000445}{9} = .000000049$$

$$\frac{0.000000445}{25} = .000000018 \text{ and } \frac{.000000018}{11} = .000000002$$

To this logarithm	Log. 0.176091258
Add the logarithm of 2 before found	0.301029994
Sum is the logarithm of 3	=Log. 0.477121252

Example 3.

Required the logarithm of 4.

Now $4=2\times2$. Then to the log. of 2	= 0.301029994
Add the logarithm of 2	= 0.301029994
Sum is the logarithm of 4	= 0.602059988

Example 4.

Required the logarithm of 8.

Now $8=2\times2\times2$. Therefore the log. of 2	= 0.301029994
Taken three times	3
Gives the logarithm of 8	= 0.903089982

Example 5.

Required the logarithm of 6.

Now $6 = 3 \times 2$. Then to the log. of $3 =$ 0.477121250
Add the logarithm of 2 ... ... $=$ 0.301029994

Sum is the logarithm of 6 ... ... $=$ 0.778151244

Example 6.

Required the logarithm of 5.

Now 10 divided by 2 gives 5 :—
Then from the logarithm of 10 ... ... $=$ 1.000000000
Take the logarithm of 2 ... ... $=$ 0.301029994

Leaves the logarithm of 5 ... ... $=$ 0.698970006

Example 7.

Required the logarithm of 9.

Now $9 = 3 \times 3$. Therefore the logarithm of $3 =$ 0.477121252
Doubled 2

Gives the logarithm of 9 ... ... $=$ 0.954242504

Example 8.

Required the logarithm of 7.

Here 6 is the next less number. Then $7+6=13=A$, and 169 is the square of A :—

$$\frac{0.868588968}{13} = 0.066814536 \text{ and } \frac{.066814536}{1} = .066814536$$

$$\frac{0.066814536}{169} = 0.000395352 \text{ and } \frac{0.000395352}{3} = .000131784$$

$$\frac{0.000395352}{169} = 0.000002339 \text{ and } \frac{0.000002339}{5} = 0.000000468$$

$$\frac{0.000002339}{169} = 0.000000014 \text{ and } \frac{0.000000014}{7} = 0.000000002$$

To this ... ... Log. 0.066946790
Add the logarithm of 6 ... $=$ 0.778151242

Their sum is logarithm of 7 ... $=$ 0.845098032

The log. of 12 is equal to the sum of the logs. of 3 and 4, or of 2 and 6; the log. of 14 is equal to the sum of the logs. of 7 and 2; the log. of 15 = log. of 3 + log. of 5; log. of 16 = log. of 4 + log 4, or of 8 + 2; the log. of 18 = the log. 6 + log. of 3, or of 9 + 2; the log. of 20 = log. of 4 + log. of 5, or log. 10 + 2.

The logarithms of the prime numbers 11, 13, 17, 19, are to be found as in the examples, and in like manner is the log. of any other prime number to be found, but it will be found that the operation is much shorter in large prime numbers. For any number not exceeding 400, the *first quotient added to the logarithm of its next less number will give the logarithm sought,* and this will be *true* to 8 places of figures, and therefore, it is an exceedingly simple and easy matter to examine any logarithmic tables, or any suspected logarithm.

TO FIND THE SQUARE OR CUBE ROOT OF ANY GIVEN NUMBER BY LOGARITHM:—

Example 1.

Required the square root of 1501, its log. ... ÷ 2) 3.17638

Of square root sought, 38.74 ... ... Log. 1.58819

Example 2.

What is the root whereof 176.6 is the 12th power?

Logarithm of 176.6 ... ... ÷ 12) 2.24686

Of sought root = 1.539 ... ... Log. 0.18724

Example 3.

What is the cubic root of 2121? ... Log. ÷ 3) 3.32654

Of cube root sought = 12.85 ... = Log. 1.10885

Example 4.

What is the root whereof 2 is the 365th power?

Logarithm of 2 ... ... ÷ 365) 0.301030

Root sought = 1.002... ... ... = Log. 0.00082

TO FIND THE DISTANCE OF AN OBJECT, BY OBSERVING THE INTERVAL OF TIME BETWEEN SEEING THE FLASH, AND HEARING THE REPORT OF A GUN OR OF A THUNDER CLOUD.

RULE.—To the logarithm of the number of seconds elapsed between seeing the flash and hearing the report, add the logarithm 9.273762 (being the sum of the arithmetical complement of the logarithm of 6080, the number of feet in a nautical mile, and the logarithm of 1142, the number of feet which sound travels in one second of time) and the sum (less 10 in the index) will be the logarithm of the distance in nautical miles; or, if the constant logarithm 9.335032 (this is the sum of the arithmetical complement of the logarithm of 5280, the number of feet in a statute mile, and the logarithm of 1142, the estimated velocity of sound) be used, it will give the distance in English statute miles.

Example 1.

A ship at sea was observed to fire a gun, and 43 seconds afterwards the report was heard. Required, the distance of the ship from the observer, in nautical miles:—

Solution.—

Interval between seeing the flash and hearing the gun, 43 seconds	Log.	1.633469
Constant logarithm		9.273762
Distance in nautical miles 8.076	Log.	0.907231

Example 2.

A flash of lightning was seen, and after a lapse of 18 seconds the report reached the ear of the observer. Required, the distance of that thunder cloud in English miles?

Solution.—

Interval between seeing the flash and hearing the thunder, 18 seconds	Log.	1.255273
Constant logarithm		9.273762
Distance of the cloud in English miles 3.894 ...	Log.	0.529035

FORM OF AN AVERAGE BOND.

Whereas the (*name of vessel*), whereof (*name of captain*) is master, having on board a cargo of merchandise, sailed from the port of bound to . And in the due performance of her voyage (*here must be stated all the facts, clearly, faithfully and truthfully, with all the circumstances which gave rise to the necessity to make a sacrifice, and to incur the expenses; and that such sacrifice and expenses were necessarily incurred for the benefit of all concerned; and that in point of law and equity, the parties concerned are liable to contribute pro rata to the general average*) by which means certain losses and expenses have been incurred, and other expenses may hereafter be incurred in consequence thereof, which according to the usages of trade and commerce, and marine insurance law constitute a general average. And the said vessel, her earnings, as freight, and the cargo on board.

Now we, the subscribers, owners, shippers, consignees, agents or attorneys, of certain consignees of said vessel or cargo, do hereby, severally and respectively, but not jointly, or one for the other, covenant and agree to, and with that the loss and damage aforesaid, and such other incidental expenses thereon as shall be made to appear to be due from us, the subscribers to these presents, either as owners, shippers, consignees, agents or attorneys of certain consignees of said vessel or cargo, shall be paid by us respectively according to our parts or shares of said vessel, cargo, or her earnings as freight, as shall belong or be consigned to us, or shall be consigned to any person with whom we are co-partners, agents, or attorneys, or in any manner concerned therein, provided such loss and expenses aforementioned be stated and apportioned by . Average adjusted in accordance with the *established usages and laws of this country* in similar cases. And for the true performance of all and singular in the premises we do severally hereby bind ourselves, our respective heirs, executors and administrators to the said in the penal sum of £ lawful money of *this country*. In witness whereof we have to these presents set our hands in the this day of in the Year of our Lord One Thousand Eight Hundred and

Cosignees	No. of packages	Invoice	Value	Description.

FORM OF RESPONDENTIA BOND.

(COMMON FORM.)

KNOW ALL MEN BY THESE PRESENTS, that we, A.B., commander of the ship , in the service of C.D., and H.L., of are held, and firmly bound, unto P.R., of Merchants, in the sum of £ , good and lawful money of this country, to be paid to the said P.R., or to his certain attorneys, executors, administrators, and assigns, to which payment well and truly to be made; we bind ourselves, jointly and severally, our heirs, executors, and administrators, firmly by these presents, sealed with our seals, dated this day of in the Year of Our Lord One Thousand Eight Hundred and
Whereas, the above named P.R., has on the day of the date above written, advanced and lent unto the said A.B., C.D. and H.L., the sum of £ upon the goods and merchandise and effects laden, and to be laden on board the good ship or vessel called the of the burden of tons, or thereabouts, now riding at anchor in the harbour of , outward bound to , and whereof, A.B. is Commander, by his acceptance of a bill of exchange to that amount, at months, date for the account of them, the said A.B., C.D. and H. L. NOW THE CONDITIONS of this obligation are such, that if the said ship or vessel do, and with all convenient speed, proceed and sail from and out of the port of on a voyage to any ports or places in and from hence do and shall sail, return, and come back into the said port of at or before the expiration of months, to be accounted from the day of the date above written, and there end her said intended voyage, (the damages and casualties of the seas excepted,) and if the said A.B., C.D. and H.L., or either of their executors or administrators do and shall within days next after the said ship or vessel shall have arrived at her anchorage in the said port of from her said intended voyage, or at or upon the end and expiration of the said month to be accounted as aforesaid (whichever of the said times shall first and next happen), well and truly pay, or cause to be paid unto the said P.R. his executors, administrators, or assigns, the full sum of lawful money of this country, together with of like money per calendar month for each and every calendar month for all such time, and so many calendar months as shall be elapsed and run out of the said calendar months, over and above

months, to be accounted from the day of the date above written, or if during the said voyage, and if within the said calendar months to be accounted as aforesaid, on either loss of the said ship or vessel, by fire, enemies, men-of-war or any other casualties, that shall unavoidably happen, the said A. B., C. D. and H. L., their heirs, executors, or administrators do and shall within calendar months next after such loss, well and truly account for, (upon oath if required,) and pay unto the said P. R., his executors, administrators or assigns, a just and proportionable average on all the goods and effects of the said A. B. carried from this country on board of the said ship or vessel, and the net proceeds thereof, and on all other goods and effects which the said A. B. shall acquire during the said voyage, for or by reason of such goods, merchandise, and effects, and which shall not be unavoidably lost; then the above written obligation to be void and of none effect; else to stand in full force and virtue.

FORM OF A NOTE OF PROTEST.

Port of }
City of }

Be it known, that on the day of in the year of our Lord One Thousand Eight Hundred and Before me a Notary Public, duly commissioned, authorized and sworn, and dwelling and practising in the city of aforesaid, personally came and appeared A.B. Master of the ship or vessel called the of the port of of the burden of tons or thereabouts, who declareth that he sailed last from on the day of 18 in the said vessel under his command laden with a cargo of general merchandise bound for and that having experienced tempestuous weather, he fears that his cargo may have sustained more or less damage (here any further particulars may be stated), and that he arrived in this port at o'clock on this day of 18 .

AND THAT the said Master thus *notes* his protest, before me, the said Notary, reserving to himself the right of extending the same at a convenient time and place.

A. B. { Verified before me, the day and year first mentioned
Master, ship { and written.

F. B. D. *Notary Public.*

FORM OF SHIP'S PROTEST.

In consequence of damage by storms and tempestuous weather, and also by jettison.

To all whom it may concern, or to whom these presents shall come.

I. F. B. D. of the city of a Notary Public duly commissioned and qualified, send greeting. Know ye, that on the day of in the year of our Lord One Thousand Eight Hundred and before me, the said Notary, appeared A. B., Master of the ship of of the burden of tons, or thereabouts, and noted in the due form of law, with me, the said Notary, his protest for the uses and purposes herein mentioned. And now, at this day, to wit, the day of and date hereof, again comes the said A.B. before the said Notary, and requires me to extend his Protest. And together with the said A. B. also came C.D., Mate, E. F., Carpenter, G. H., Second Mate and I. J., seaman, of and belonging to the said ship, all of whom being by me duly sworn on the Holy Evangelists of Almighty God, did severally declare and depose as follows: That is to say, that, on the day of he, the said A. B., set sail and departed in and with the said ship as Master thereof, from the port of having on board the said ship a cargo of general goods bound to . That the said ship was then tight, stiff, staunch and strong, had her cargo well and sufficiently stowed, dunnaged, and secured, and the said ship was well masted, manned, tackled, victualled, apparelled, and appointed, and was in every respect fit for the sea, and the voyage she was about to undertake. That on the day of their departure the breeze was moderate, that they proceeded on their voyage with fine weather and variable winds accompanied with occasional showers of rain until the day of when they experienced fresh gales from the with heavy squalls, causing a heavy sea, and they shipped large quantites of water on deck, and over all parts of the ship. Noon, the sea increasing, ship plunging bowsprit in; on the they had increasing gales, causing the ship to labor and strain much, and to begin to make water, every attention was paid to the pumps. Sail was reduced according to the necessities of the case, and they continued on their course without any extraordinary occurrence until the day of when they experienced a heavy gale from the N.N.E., causing a tremendous cross sea, which continually broke over the vessel, this state of things continued until midnight, when the ship

made more water than usual, the pumps were kept constantly going. On the more moderate at o'clock, the gale again sprung up from N.N.W. at 10 P.M., the jib sheet parted and the sail blew away, before it could be stowed, on the more moderate, bent another jib. They proceeded on their voyage until the day of when a strong gale came on from the north, which increased rapidly, close reefed the top-sails, handed the jib and courses, ship labored much and besides making water, shipped great quantities over all, pumps constantly going. At o'clock gale increasing and the sea getting more furious, at P.M., a tremendous sea broke on board which tore the long-boat from her fastenings. Carried away the quarter-boats, davits and all, making a clear sweep of the decks, carrying away the main rail from the fore part of the main rigging to the fore rigging, both sides, breaking seven stancheons on the starboard and five stancheons on the port side of the ship, and splitting the covering board, carried away the galley, spars, stud-sails and various other valuable articles of the ship's tackle and furniture. The pumps were kept going. At o'clock they experienced tremendous squalls, handed the mizen and the fore-top sails. At midnight blowing a perfect hurricane, in an attempt to hand the main top-sail it blew away, the ship now under bare poles, labored and strained fearfully—the mate, second mate, and carpenter endeavoring to nail tarpauling over the openings in the covering board, all hands at the pumps. On the the gale continued, the ship in the same state as yesterday; except that she made more water, it requiring every effort to keep her free with both pumps. At P.M., the squalls became more terrific, throwing the ship completely on her beam-ends. We now found it impossible, notwithstanding the most strenuous exertions on the part of all on board to keep the ship free with both pumps and that the water gained on the pumps which were plied at the minimum rate of 120 strokes per minute. Now, I, A.B., consulted with the officers and with the super cargo on board, and found that we were obliged, in order to lighten the ship, and for the preservation of the vessel, crew, and the rest of the cargo to throw overboard part of the cargo, consisting of *(here describe the goods or articles voluntarily thrown over board and sacrificed for the common benefit)* which was accordingly done. The weather continued the same until the noon of the day of when it moderated, crew being entirely exhausted by their long continued exertions; and by observations we were in latitude ° ′ ″ N and ° ′ ″ W longitude. That we adjudged it best for the interests of all concerned to bear up for a port for repairs. Bore up accordingly

for the port of which was immediately under our lee, and the most convenient. On the day made the land at o'clock, and at P.M. And this appearer A.B. also declares that on the same day he appeared at the office of the said Notary and caused this protest to be noted. And the said appearers further say that all the damage and injury which has already, or may hereafter appear to have happened or occurred to the said ship or her said cargo, has been occasioned solely by the circumstances hereinbefore stated, and cannot, nor ought not to be attributed to any insufficiency of the said ship, or default of him, this deponent, his officers, or crew.

He now requires me, the said Notary, to make his protest, and this public act thereof, that the same may serve and be of full force and value as of right shall appertain. And, therefore, the said A.B. doth protest, and I, the said Notary, at his special instance and request, do by these presents, publicly and solemnly protest against the aforesaid bad and tempestuous weather, gales, storms, force of winds and waves, accidents and occurrences, and all loss or damage occasioned thereby, and against all persons whom it doth, shall, or may concern, and against all and every accident, matter and thing had and met with as aforesaid, whereby, or by means whereof, the said ship or her cargo have received, or hereafter shall appear to have suffered or sustained, damages or injury for all losses, costs, charges, expenses, damages, and injury, which the said ship, or the owners, freighters, or shippers of the said cargo, already have or may hereafter pay, sustain, incur, or be put unto by, or on account of the premises, or for which the insurer or insurers is or are respectively liable to pay, or to make contributions or average, according to custom, or their respective contracts or obligations, and that no part of such losses and expenses already incurred or hereafter to be incurred, do fall on him, the said A. B., his officers or crew.

Thus done and protested in the city of this day of in the year of our Lord One Thousand Eight Hundred and . In testimony whereof I have caused the said applicants to sign these presents, and I, the said Notary, have subscribed my name, and have also caused my seal of office to be hereunto affixed, the day and year above written.

F. B. D.

Notary Public. [*L. S.*]

(Master.)	(Carpenter.)
(Mate.)	(Seaman.)
(2nd Mate.)	(do.)

MARINE INSURANCE.

ABANDONMENT AND TOTAL LOSS.

What is meant by abandonment, as understood by marine insurance law?

An abandonment is an act on the part of the commander, as agent for the owner, by which he changes the interest of the subject of insurance from the owner to the underwriter. This may be done by giving up the ship or property to the underwriter or his authorized agent, or simply by ceasing to act for the owner, and beginning to act for the underwriter. As the captain is the agent for all parties concerned, it is his manifest duty to preserve every part of the property that may remain after damage or loss has been sustained.

What constitutes a right to abandon?

The insured has a right to abandon when the object of the voyage has been defeated by any of the dangers insured against, even though the loss may not be an absolute total one. Yet, if the ship, or subject insured, be so far damaged, that it would be as well if they had been lost entirely, and the voyage is now not worth pursuing, he may abandon.

What is a total loss within the policy of insurance?

A total loss, within the meaning of a policy, is, where by the dangers insured against the subject is totally lost, or so damaged, as to be of small value; or where the insured is deprived of the further use of the thing insured?

What is a technical total loss?

A constructive, or technical total loss, is that in which some part of the subject insured is surviving, or some claim accruing from it against a third party.

What quantity of damage constitutes a total loss, technically understood?

Any damage to a ship that cannot be repaired at a port of necessity, for less than half what the ship will be worth at that port when repaired, after making the deductions called for in the policy, may be made a technical total loss.

Within what time after notice of the loss must abandonment be made?

Within a time considered reasonable, by a judge and jury, and that must depend on circumstances; but delay, with a view to speculation, will not be allowed.

When the assured receives notice of a loss, must he elect whether he will abandon or not?

He must. And if he intends to abandon, he must give notice of such intention to his underwriters.

How is a captain to decide whether he is right in abandoning for a technical total loss on a policy on a ship?

He should know that he has a right, as agent for the insured, to abandon, when, from any of the perils insured against, the ship is for the present rendered unfit to fulfil the object of the voyage, and is no longer under the control of the owner, and the expenses so great, and the time so uncertain, or unreasonably distant, and out of proportion to the expected benefits and object of the voyage, the law will justify him in treating her as a total loss, though she has a physical existence.

In what does the right to abandon consist?

In the amount of damage by the perils insured against.

Is fear or cowardice a just cause of abandonment?

Certainly not. Actual damage *must have been sustained* to justify abandonment.

If a ship should be long missing, can a total loss be recovered?

It may.

Has an agent who insures a right to abandon for his principal?

He has.

Should a ship be stranded, is the captain justifiable in abandoning?

No; not if she can by *any* means be got off, at an expense less than one-half her value when repaired, after the usual deductions of one-third new for old.

When a ship is stranded on a deserted coast, where neither men nor materials can be had to get her off, or to a port where repairs may be made, is a captain justifiable in abandoning?

In such a case, he may abandon.

In case a ship be picked up at sea, derelict, and brought into port, and restored to the owner, can he abandon?

No; unless she be so damaged, and cumbered with claims for salvage, &c., that the loss is within the technical meaning of a total loss.

If a ship suffer from the perils insured against, but arrives at her port of destination, in a disabled state, can the owner abandon there?

Yes; if the ship is not worth repairing. The rule as to abandonment is, that if the ship or goods insured be damaged to more than half the value by perils insured against, or more than half the freight be lost the assured may abandon.

Suppose a ship received damage from the perils insured against but the repairs do not amount to one-half the value; yet the captain cannot raise the money on his own, his owners, nor on any other credit, nor on bottomry, is the captain justifiable in abandoning?

Yes; and he may sell the ship. The underwriters will be liable for a total loss, unless it be made to appear that it was the fault of the owner in not providing the captain with funds or credit.

Should a repair be gone into, and before it is finished an abandonment is tendered, will it be valid?

Yes; whether the expenses already incurred amount to more or less than fifty per cent.

If a ship be partially repaired, and taken to another port for complete repairs, can an abandonment be then tendered?

Yes; if the complete repairs amount to over fifty per cent.; but it must have become evident that the whole expense will amount to more than one half the valuation in the policy.

In computing a total loss, by damages over fifty per cent., should a third for new be first deducted?

No.

What is the effect of a sale by the master, made in good faith, and for just cause, for the benefit of all concerned, of a ship and cargo?

The underwriters are liable for a total loss, provided the sale was a matter of absolute necessity.

Is the captain obliged to tranship cargo in case of innavigability of the ship?

If there be another vessel in the same or a contiguous port, he is bound to hire it.

What is the meaning of innavigability?

When, by the perils of the sea, a vessel is rendered unfit for service; or when to repair her, would cost as much time and money as would build a new one.

What is a total loss of goods?

When they are so damaged as to be of little value, and the adventure insured is broken up. If goods be damaged to over fifty per cent of their value, it may be made a technical total loss.

How is the half value to be ascertained on goods?

The difference between the gross proceeds of the sound ar damaged goods shows the amount of injury.

What is stranding?

A ship is said to be stranded, when she accidently takes the grou and remains there a tide, or for some considerable time.

What is the effect of an abandonment?

If an abandonment be rightly made, it is binding and conclusive between the parties, and the agent for the assured becomes the agent for the underwriter, who now takes the place of the assured.

Is any particular form of abandonment necessary?

No; nor need it be in writing; but the assured must state his grounds for abandoning, explicitly and unambiguously; and the notice must be founded upon such facts as will sustain the abandonment when made.

What is the rule as to the abandonment of freight?

That, in case of a technical total loss of the vessel, if no freight *pro rata* is earned; or if the expenses of sending on the cargo by another vessel will exceed the half of the freight agreed on by the charter party, it is a technical total loss of freight, and authorises an abandonment of it.

What is the rule as to the abandonment of memorandum articles?

An abandonment for deterioration on the voyage can *only* be made when the memorandum articles exceed one-half the cargo. In case of perishable articles within the memorandum, the underwriter is secure against all damage to them, whether great or small, whether it defeats the voyage or only diminishes the value of the goods, unless the articles be completely destroyed, so as to have no physical existence.

SHIP'S MEDICINE CHESTS.

HEALTH OF CREW AND PASSENGERS.

On the health of the crew the success of the voyage must, in a great measure, depend; yet it must be confessed that very little attention is paid, in the majority of vessels, to the accommodation, provisions and medicine provided for them. Many ships go to sea without any medical comforts, and without any accommodation worthy the name; and too often the "medicine chest" presents to the eye, a chaotic mass of bottles without stoppers or labels, containing what once had a name (in Latin,) but which is now only fit to be thrown overboard. No vessel should be permitted to go to sea without a properly fitted medicine chest; a large and airy, yet securely enclosed fore-castle, with dry berths, in proportion to the number of the crew. A dose of castor oil, epsom salts, or calomel often saves a topsail, or it may be the masts and ship. Our ships are generally short-handed enough, and cannot

afford to have men on the "sick list," while proper medicines, good food, and a well ventilated dry fore-castle, will keep them well, and able to do their duty. Scurvy among a crew at the present day, bespeaks great carelessness and neglect on the part of the owner and captain of the ship. It has been proved, beyond the possibility of a doubt, that scurvy is induced by bad water, long continued living on old, and consequently over salted provisions, want of vegetable matter, want of cleanliness, and the loathsome vapors arising from the "dog-holes" in which the men are forced to live. All these evils may now be avoided. Water need no longer be carried in casks, nor even in tanks; thanks to the enterprising firm of Winchester, Graveley & Sager, whose admirable distilling apparatus furnishes a daily and abundant supply of pure fresh water, for any number of crew and passengers. Vegetables too, and preserved fresh meats are not only abundant but cheap; and a fresh mess to the crew twice a week, would be amply repaid in *time*, for the crew being well, sail could be carried longer, taken in quicker, sail made easier and quicker, and the ship worked off a lee shore with less difficulty than if the men were laid up with scurvy and other diseases. There has been a great deal said and written, and some things have been *done*, to reduce the "dangers of the sea" as much as possible. Seamen and marine underwriters have much reason to be grateful to those who invest capital and expend their energies for their benefit. The hardships and dangers of a voyage to China, India, or the West Coast, formerly experienced by seamen, need no longer exist. Have we not Redpath and Leigh's Patent Pumps? Downton's Portable Fire Engine? Graveley's Distilling Apparatus, and many other excellent inventions and improvements? which render the longest voyage a mere pleasure trip, in comparison to the discomfort of former years. Intermittent and yellow fevers, and dysentery, are invariably the offspring and result of a continued use of bad water. Therefore persons travelling on long sea voyages, should choose those ships that are provided with the patent distilling apparatus, in order to secure an abundant supply of pure, wholesome water. And as further precaution against these diseases in tropical climates, the following hints are thrown out. Any one, however strong his or her constitution may be, is more or less affected by a sudden change from a cold and healthy, to a warm and unhealthy climate; but by taking the following precautions the risk of sickness will be materially diminished:—Wear flannel drawers and undershirts, with sleeves to the elbows; sleep with the flannel shirt on. Wear woollen or half woollen stockings. Always keep a suit of the above ready to change in case of profuse perspiration.

In countries subject to intermittent fevers or cholera, avoid being out of doors at night.

Sickness is often caused by a sudden change from the hot and close air of the forecastle or house, to the "fresher atmosphere" filled with dampness, on deck or out of doors. Dysentery or fever may be induced in a few hours by this kind of exposure, especially if the person has been at all irregular in his diet or habits. Never send your men, nor go out in the sun in Africa or India, if it can be avoided. White umbrellas should be used by those who are obliged to go out in the sun. Wear a hat with a ventilator. Be moderate in all things, especially in eating and drinking. Avoid raw fruits of any kind, and above all pine-apple, or fruits of the same acidity. Do not believe the fallacious assertion that "a little brandy, or brandy and water at dinner helps digestion." This is an excuse for indulging in strong drink, but it is a great error. If much rice is eaten, it should not be cold, and a reasonable quantity of cayenne pepper should be mixed with it. Take cayenne pepper with all meats eaten for breakfast and dinner, this will be far more beneficial than brandy. Avoid fresh vegetables for some time after arrival in a new climate. Never drink iced or soda water, or any thing so cold; Hock and Claret are the only wines that should be drank at meals, and these should be mixed in two parts of water. Toast and water is a beverage which is everywhere at hand, and is besides very refreshing for the blood, and does not predispose people to congestion of the brain, as brandy does. It is said in the West Indies, as in all hot climates, that taking a glass of brandy after having eaten a raw banana or plantain, will surely cause death. I do not know to what extent this may be true, but it is certain that brandy, or any other spirits, will harden instead of assisting the digestion of the plantain in the stomach, and dysentery is produced, which is nearly always fatal.

Keep the bowels free, by using an infusion of senna flowers or leaves, or pills containing proportions of senna, jalap, rhubarb and aloe. Ship masters are frequently invited, in the East and West Indies, to dinners, where they allow themselves, on the faith of ignorant or *interested* hosts, to indulge in strong drinks, followed by Champagne, and to trust to the pretended healthiness of the climate. Such invitations, however pressing, should be declined. The sudden change of diet from ship-board, salt meat and biscuit, to fresh meat and fresh vegetable food, should be avoided; this change frequently produces dysentery. Men and officers, when in port, should avoid, by all means, the danger of sleeping on deck; nor should this practice be

allowed at sea, unless forty miles from the effects of the land breeze, which drives before it the poisonous malaria from the shore. These opinions, like the rest of this work, are practical, founded on experience. The author never lost a man from fever, though he has served for three years on the Coast of Madagascar and Mozambique, and for five on the South West Coast of Africa and West Indies, with a crew of forty-five men. His practice was to keep his crew and officers from rain and sun, by means of awnings, and obliging them to keep in motion during night watches, to change clothing before going to bed, to avoid bathing in rivers, and to keep their persons and forecastle perfectly clean. Exercise during the day, the resistance to sleep, except during the night time, contribute to health; the habit of taking a nap, or siesta between meals, however short, must be avoided. Activity never injured any one, but has helped many to resist the first attack of a fever, which one accustomed to give himself up to rest cannot so easily withstand. A good preventative against the effects of malaria is quinine in small quantities two or three times a day, say two grains at a time in the morning, at noon, and in the evening, mixed with a spoonful of Claret Wine. Liver affections are brought on by a long continuance in hot climates; exercise on horseback, change of air to the mountains, a judicious use of mercury in the shape of pills twice a year, are beneficial in such cases.

As constitutions differ as much as tastes, and, therefore, what will benefit one would injure another, every one should exercise judgement in the choice of food, and the manner of taking precautions against sickness, though I believe that the general directions here given may be followed by every one without injury; but still let it be remembered that PURE WATER is the great life and health-giving principle of a long sea voyage. Therefore I gladly give space to the following communication received from that experienced and intelligent ship master, E. P. Ellis, Commanding the Ship *Empress*, of London, on his arrival from a voyage to Auckland, New Zealand, and India. The Captain writes:

"Ship *Empress*,
"London Docks, January 19th, 1865.

"CAPT. BELL,

"DEAR SIR,—

"As you are about to publish a work for the general good of seamen and benefit of owners and underwriters, will you permit me to add my mite in that direction, in favour of that greatest

of all blessings, 'Graveley's Sea-water Distilling Apparatus.' Having had one of these invaluable machines in use on my last voyage to New Zealand, Calcutta and back, I can speak with confidence to its many advantages, not only in giving a plentiful supply of excellent, pure and wholesome water, but the cooking arrangements for five hundred troops, and the attachment for supplying and working the fire engine in case of need, and for washing decks. I consider this invention, though simple, still the most important of the present century. Passengers and crew are no longer exposed to the danger of being short of water, from rats cutting into casks, no longer compelled to drink poison from rotten wood, while the health of the commander, officers, and crew is preserved, and the ship, cargo and lives of all on board rendered more safe, and far less exposed to the 'dangers of the sea.' I feel assured that in a short time, this excellent apparatus, which cannot be too highly appreciated, will become as general as Chronometers; and that ships that are not provided with 'the distilling apparatus' will have to lay in port for want of commanders, officers and crew.

"I remain, dear sir, yours faithfully,

"E. P. ELLIS,

"Commanding Ship *Empress*, of London."

TABLE SHOWING THE WEIGHTS OF DIFFERENT SIZED ROPES.

HEMP ROPE. Coils 130 fathoms.				MANILA ROPE. Coils 140 fathoms.			
Inches.	Cwt.	qrs.	lbs.	Inches.	Cwt.	qrs.	lbs.
10	33	"	"	10	25		"
9½	30	"	"	9½	22	2	"
9	27	"	"	9	20	"	"
8½	24	3	"	8½	18	2	"
8	21	1	"	8	16	"	"
7½	18	3	"	7½	14	"	"
7	16	1		7	12	1	"
6½	14	"	"	6½	10	2	"
6	12	"		6	9	"	"
5½	10	"	"	5½	7	2	"
5	8	1	"	5	6	1	"
4½	6	3	"	4½	5	"	"
4	5	1	"	4	4	"	"
3¾	4	2	"	3¾	3	2	"
3½	4	"	"	3½	3	"	"
3¼	3	2	"	3¼	2	3	"
3	3	"	"	3	2	1	"
2¾	2	2	"	2¾	1	3	14
2½	2	"	"	2½	1	2	"
2¼	1	3	"	2¼	1	2	7
2	1	2	"	2	1	"	14
1¾	1	1	"	1¾	1	"	"
1½	1	"	"	1½	"	3	"
1¼	"	3	7	1¼	"	2	14
1	"	2	14	1	"	2	"

Hence the weights of any other length of coils, or the weight per fathom of any sized rope, may easily be found by the rule of proportion; and this will serve as a check to accounts, in supplying or purchasing rope at home or abroad.

THE END.